THE SCOTTISH HORTICULTURAL RESEARCH INSTITUTE

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The official opening of the Institute on June 16th, 1956

Right to left : Mr Gilchrist, Mr Scarlett, Mr Lowe, Professor Robertson, Mr Storrie, Sir Alexander Glen, Professor Matthews, Mr Macpherson, Dr Swarbrick; extreme left Professor Watson

THE SCOTTISH HORTICULTURAL RESEARCH INSTITUTE

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THE DIRECTOR'S REPORT

A milestone in the Institute's history was the official opening of the new laboratory building by Mr Niall Macpherson, M.P., Joint Parliamentary Under-Secretary of State for Scotland, on June 16th, 1956. The day was somewhat marred by the bitterly cold and windy weather. The ceremony was preceded by a lunch in the long barn at which some fifty distinguished guests were entertained to lunch by the Governing Body. These included the Lord Lieutenant of Perthshire, the Right Honourable Lord Kinnaird; the Lord Provost of Dundee, Mr William Hughes; the Secretary of the Department of Agriculture, Sir Alexander Glen; the Secretary of the Agricultural Research Council, Sir William Slater; the Principal of the University of St Andrews, Professor Knox; the Master of Queen's College, Dundee, Professor Dow; the Principal of the West of Scotland Agricultural College, Mr Hendry; local Members of Parliament, Directors of research institutes in Britain and many prominent fruitgrowers. We were particularly glad to welcome Mr N. H. Grubb and Dr R. V. Harris, both of whom have contributed so much to the revival of the Scottish raspberry industry, and Dr F. R. Tubbs, Director of East Malling Research Station. Most unfortunately, illness prevented Professor T. Wallace, Director of Long Ashton Research Station, from attending.

After the ceremony, guests toured the new building and precincts and discussed with members of staff the various exhibits illustrating work in progress at the Institute. When the formalities were all over the staff sought relaxation in an evening supper and dance in the course of which presentations were made to the Director and Mrs Swarbrick to mark the memorable occasion.

Mention must be made of the floral decorations that helped to brighten the day. In the long barn, Mr D. L. Storrie staged an exhibit of fruit trees and strawberries, including Talisman, all in full fruit, and credit is due to the Institute's glasshouse staff for producing a display of bedding plants outdoors at a particularly awkward time of year.

THE YEAR 1956/57

The various departmental reports show that the year has been a rewarding one in many directions. Much of the work in progress is designed to produce new and better crop varieties and to devise methods of getting the best out of those we have. The decision to release, in spring 1957, another of Mr Reid's strawberry seedlings, to be named Redgauntlet, will be welcomed by growers. A description of the variety appears in this report and its performance at Auchincruive, Mylnefield and in the National Fruit Trials is highly encouraging. Work on the various aspects of raspberry culture, such as row spacing, height of winter tipping and methods of planting, cane selection and training is yielding consistent results of importance to growers, and the breeding programmes for raspberries and black currants promise interesting results. Two

further reports on vegetable variety trials, this time on stringless French beans and on brussels sprouts, appear below. Whilst the ultimate object of most of the vegetable trials in progress is the selection of suitable parent material for future breeding work, unbiassed assessment of so many commercial strains of vegetable varieties is extremely valuable. Gamma- and neutron-irradiation of seed is being tried as a means of inducing mutations in brussels sprouts and cabbage. Further work on the physiology of growth of the strawberry has confirmed the interesting observation that plants exposed to short days revert to a vegetative behaviour and fail to initiate flowers when connected by stolons to plants exposed to long days. Cold storage of strawberry runners for long periods has proved feasible and offers useful commercial possibilities. The pests and diseases which affect crop plants are also continuing to receive our attention. The work on June Yellows of strawberry is now beginning to yield interesting results. A start has been made in investigating the factors that determine the incidence of some of the fungus diseases which are spread by air-borne spores. Soil transmission of raspberry ringspot virus, the cause of Scottish raspberry leaf-curl disease, has been established and investigation of this problem has led to the discovery of several other ringspot viruses that infect a wide variety of crop and weed plants and are also soil-borne. Results from work on the insect vectors and the spread of potato leaf roll and Y viruses seem likely to have important implications for Scottish seed-potato growers.

BUILDINGS, FARM AND PLANTATIONS

The extension to the Plant Pathology glasshouse block was completed by mid-summer and promptly occupied by the plant pathologists. Competition for glasshouse space is severe and the erection in 1957, of another block of houses to serve the Pomology, Crop Physiology and Vegetable Culture Departments should do much to relieve the present congestion. Heating of the main glasshouse block was improved by enlarging the boiler and fitting an automatic stoker, and an independent boiler and heating pipes have been installed in the house used for work on June Yellows disease of strawberry. A small Dutch light house was erected by the Edinburgh and East of Scotland College of Agriculture for raising, in co-operation with us, material for exhibition at the forthcoming Royal Highland Show in Dundee. In the main building one of the small rooms has been fitted up as a sterilising room for the Mycology Department and the culture room has been modified and fitted with new benching. Preparation of anti-sera to plant viruses was begun this year by the Plant Pathology Department and a range of hutches was built to house the rabbits used for this purpose.

The planting of a mixed coniferous and deciduous windbreak along the main section of the Mylnefield-Bullion boundary was begun in spring 1956 and completed in late winter 1957. Along the new approach road from the south, trees of crab (varieties John Downie, Veitch's Scarlet and Dartmouth Crab), Chinese mountain ash (*Sorbus discolor*) and Swedish whitebeam (*S. intermedia*) trees were planted in March 1956, and plans have been made for an initial planting of ornamental trees and shrubs in the vicinity of the new building.

The wet summer interfered greatly with work on the farm, particularly cleaning operations and the harvesting of the soft fruit and cereal crops. Pasture and root crops grew well, grain yields were moderate but the sugar beet crop was disappointing this year. Fifty head of cattle were fattened on grass. These made only moderate prices in autumn but trade improved during the winter. Thirty-seven were wintered in the courts at Bullion. Soft fruit crops were heavy; strawberries yielded 5 tons and raspberries 25 tons. The black currant crop, 15 cwt., was poor as a result of damage to the flowers by spring frosts. We again co-operated with the Ministry of Agriculture, Fisheries and Food by supplying vegetables and fruit for dehydration at their Aberdeen Experimental Factory. Some 18,000 canes from our healthy stocks of Lloyd George, Norfolk Giant and Malling Exploit raspberry were distributed to growers in Britain and at the present time arrangements are being made to send out some 60,000 runners of the new strawberry variety, Redgauntlet.

STAFF

In September, we welcomed Mr W. Fordyce back to the Pomology Department on his return from National Service. At the same time we temporarily lost the services of Mr D. W. Burd through illness; Mr D. Willis was appointed in March as a temporary assistant pending Mr Burd's return which, we hope, will not be long delayed. By arrangement with the R.A.F. authorities at Leuchars, Fife, Mr D. Cranston has been a voluntary worker with the Department for one day a week since the late summer. Mr H. Taylor was transferred to the Vegetable Culture Department in April.

In May, Mr R. M. Lister, formerly plant pathologist in the West African Cacao Research Institute's field station at Moor Plantation, Ibadan, was appointed to the staff of the Plant Pathology Department. In January, Dr A. R. Wilson, was appointed as head of the Mycology Department. He was formerly officer-in-charge of the Agricultural Research Council's Unit of Potato Storage Investigation at Sutton Bonington, Leicestershire. The Institute has fallen heir to a large proportion of the equipment formerly used by Dr Wilson's Unit and for this we are greatly indebted to the Agricultural Research Council. The Director's personal secretary, Miss J. Gordon, left in February to take up an appointment in Lagos, Nigeria.

Mr North was awarded the degree of Ph.D. by the University of St Andrews for a thesis entitled "Studies in the morphogenesis of cabbage (*Brassica oleracea L. var. capitata*) with special reference to the phenomenon of heading."

OTHER ACTIVITIES

During the year, Dr C. H. Cadman visited Poland as the guest of the Polish People's Republic and read a paper to the 7th Polish National Congress of Horticulture that celebrated the opening of the new Research Institute of Pomology at Skierniewice. Dr B. D. Harrison visited the Netherlands for two weeks to study Dutch work on plant virus diseases and the special techniques used by Dutch workers. At home several lectures were given to growers and papers read to scientific societies by the Director and other members of staff.

Apart from visitors at the official opening ceremony, the Institute received many other visitors from both the United Kingdom and overseas. We were particularly glad to welcome the governing body of the National Institute of Agricultural Engineering; Dr Hamilton, Head of the Plant Pathology Department, New York Agricultural Experiment Station, Geneva; and Professor Winter, Head of the Department of Horticulture, University of Minnesota. Visitors were also received from Alaska, Canada, India, Jugoslavia, the Netherlands, New Zealand, Pakistan, Poland, South Africa and Sweden. Grower's Day was held on July 21st in excellent weather and some 250 visitors toured the fruit and vegetable plantations.

COLLABORATION

Assessment of the processing quality of fruit and vegetable varieties is of great importance and in this aspect of our work assistance has been given by the British Food Manufacturing Industries Research Association, Leatherhead; Messrs Chivers and Sons, Ltd., Montrose; Eastern Counties Preserves (1940) Ltd., Forfar; Messrs Smedley's Ltd., Dundee; Messrs Rowntree and Co. Ltd., York; and the Ministry of Agriculture, Fisheries and Food's Experimental Factory, Aberdeen. Messrs Plant Protection, Ltd., Messrs Fisons Pest Control, Ltd., and several local growers collaborated in trials of herbicides for control of weeds in raspberry plantations. Dr A. M. Smith of the Edinburgh and East of Scotland College of Agriculture helped with the planning of experiments on raspberry nutrition and the Institute is indebted to the Agricultural Research Council's Unit of Statistics, Aberdeen, and to the Statistics Section of East Malling Research Station for help in the design and statistical analysis of experiments.

In the course of their work in this area the staff of the Scottish Soil Survey made a detailed survey of Mylnefield and Bullion farms and prepared a soil map of these for us. The Chief Surveyor of the Department of Agriculture for Scotland and his staff again prepared the Institute's Annual Farm and Plantation Cropping Record and the map reproduced in this report.

The library received gifts of sets of Annual Reports from both the East Malling and Long Ashton Research Stations; the Danish State Horticultural Research Station (Statens Forsøgsvirksomhed i Plantekultur) kindly donated a set of their periodical Tidsskrift for Planteavl; and Mr R. L. Scarlett, Sweethope, Musselburgh, gave a set of the Transactions of the Highland and Agricultural Society of Scotland.

POMOLOGY

C. A. Wood

The 1956 season at Mylnefield was a satisfactory one for most types of fruit. Although the weather in July and August was unsettled, the raspberry crop exceeded estimate and was nearly all of good quality. In contrast to 1955 there was scarcely any failure of canes or buds of the kind attributable to winter injury. Strawberries also were good both in yield and quality, with a remarkable freedom from mildew, a disease very troublesome in previous years.

Our oldest apple plantations are now cropping and producing useful information. Gale damage during the year, mainly in late July and early August, though not serious, was enough to re-emphasize that exposure to wind is a major hazard faced here in the growing of tree fruits.

THE CULTIVATION OF RASPBERRIES

In the oldest field experiment on cultural factors in raspberry growing, that comparing distances of planting and heights of winter tipping, yields per acre were again highest at the closest inter-row distance (rows 5½ feet apart) and lowest at the widest distance (rows 8½ feet apart), performance per individual stool being in the reverse order. The average yields per acre for rows at 5½, 7 and 8½ feet apart were respectively 86·4, 69·1 and 59·7 cwt. Except for the dry season of 1955, when cropping at the different planting distances did not vary significantly, these results have been very consistent since 1951. The total crop since 1951 from the 5½-feet rows is now nearly 3 tons per acre greater than from the 7-feet rows, which in turn have yielded 2 tons more than the rows at 8½ feet. Because of the short cane growth in the previous year it was impracticable in 1956 to compare the same three heights of winter tipping on all three varieties, and these treatments were omitted altogether from Lloyd George. Norfolk Giant, tipped at 5, 4½ and 4 feet above ground level, and Malling Promise, tipped at 4½, 4 and 3½ feet, gave lower yields with each reduction in height, again a result which confirmed previous experience. The reductions in crop on the hardest-tipped plots were significant at $P=0{\cdot}05$.

A first survey was made of the cropping value in this experiment of buds situated below the bottom training wires, which are fixed at 27 inches above ground level. In the rows with stools spaced at 36 inches apart the average percentage of nodes producing fruit-bearing laterals was significantly higher ($P=0{\cdot}05$) than in rows with stools at 30 or 24 inches apart. There were also distinct differences between varieties, Lloyd George having the highest percentage of productive basal nodes and Malling Promise the lowest. Inter-row distance, however, had no significant effect on the performance of these nodes.

The experiment to compare the value of planting canes singly with planting in twos ("double" planting), begun in 1952, again showed no significant

difference of yield between the two treatments. The initial effect of method of planting has thus disappeared, but for reasons given in previous Reports the experiment will be continued for an average plantation life.

In the experiment with Malling Promise and Lloyd George on frequency of picking and number of canes fruited per stool, there was again no significant difference between the yields obtained by picking at 4-day and at 2-day intervals. Picking every 4 days actually gave a slightly larger crop. This result was surprising, for it was expected that the more normal rainfall of 1956 would produce a return to the pattern of cropping of the years 1952-54, when more frequent picking gave higher yields. The numbers of fruiting canes per stool compared in 1956 were 5, 6, 7 and 8, one more cane at each level than in 1955. Average fruit yields at the four levels were respectively 81·9, 91·0, 95·6 and 97·3 cwt. per acre, the last figure representing a significant increase ($P=0·05$) over the first two. This result indicated a still higher level for optimum cane number per stool than was suggested by the 1955 results. Both aspects of the experiment are being studied on a smaller scale in the fruit cage (see below).

The experiment to compare methods of treating the tops of canes (var. Malling Promise) in posted and wired rows again gave its highest yield from the treatment in which the tops are arched-over at normal tipping height, re-tied to the upper wire and shortened closely below the wire. Next came the untreated plots (with the tops free and untipped) and those given normal tipping treatment. Late tipping, after bud-burst, apparently depressed yield. This experiment has now given consistent results for three years except for the variable performance of the untreated plots, which are very liable to wind damage.

First full cropping results were obtained in 1956 from three experiments planted in 1954. Of these, two are concerned with systems of training alternative to the post-and-wire method, and the third compares the normal Scottish practice of maintaining permanent fruiting stools with the alternative of allowing the canes to form a continuous narrow row, or " hedge." In 1956 the stooled rows of the last experiment slightly outyielded the non-stooled. This is a case where records of the number and quality of the fruiting canes are particularly important in relation to the cropping results, and in which the comparative value of the two systems must depend partly on the method of cane-thinning used. The method to be adopted as from autumn 1956 consists of retaining up to a maximum of 7 new canes for each original plant: this will mean that for at least a further year or two the non-stooled rows will carry the higher number of fruiting canes.

In the two experiments on training systems, higher yields were obtained by the post-and-wire method than by arching-over the canes from stool to stool or tying them into vertical bunches; but the differences were small, except in Lloyd George, and the results have not yet been analysed statistically.

Mention was made in the last Report of two new experiments (both with the variety Norfolk Giant) planted in 1955/56. One of these has now confirmed earlier work with Malling Promise which showed that canes lifted from a nursery in any month from November to April could be established successfully in spring. The other, comparing autumn- and spring-planting of canes

lifted in autumn, has shown a slight advantage from spring planting; but any conclusion on this point will be subject to confirmation over several seasons.

All the work so far reviewed has been concerned with the manipulation of canes and stools under a standardized system of manuring and soil cultivation. Now that the older experiments are nearing completion it is planned to widen the study by introducing questions of nutrition and soil management, which are of great practical interest both because healthy planting stocks are becoming available to the industry and organic manures are increasingly scarce. Two major nutritional experiments will be planted in spring 1957, together with others in which differential fertilizer levels will be included with other treatments.

The smaller experiments planted in 1955 in the fruit cage made good progress and gave detailed information that should have a useful bearing on parts of the field work.

PLANT BREEDING

Raspberries

In the shorter-term section of the raspberry breeding programme, a first assessment was made of four intervarietal crosses each involving Malling Exploit as one parent. These families were raised from seed in 1954. As with previous crosses involving Malling Jewel, many of the seedlings had thorny canes and soft-textured fruit. Forty-seven were selected for extended trial and the complete families will be re-examined in 1957. Three more crosses between varieties and seedlings of red raspberry were made during the year.

As the start of a longer-term programme, which will involve considerable initial inbreeding, some 30 varieties and seedlings were self-pollinated during the year and their seed sown in the autumn. These families should give information on the segregation of characters and provide material for further breeding work. Fifteen interspecific crosses of *Rubus* were also attempted, of which five produced seed.

(D. W. Burd.)

Black Currants

The long-term prospects for black currant growing in Scotland are encouraging, especially in relation to extending the working season for processors. The chief difficulties that hinder the commercial development of the crop appear to be the high susceptibility of many British varieties to injury by frost and cold weather in spring, and their inability to ripen quickly or evenly enough on the strig for the bulk of the fruit to be cleared in one picking. Infection by leaf spot (*Pseudopeziza Ribis*) is also a factor, particularly in the west.

An attempt is now being made to overcome these problems by breeding. As a short-term approach, crosses are being made between British varieties and varieties from Canada, Scandinavia and Northern Europe thought to possess greater hardiness and quicker or more even ripening. Twenty-one such crosses were made in 1956. A longer-term programme is being based on the inbreeding of varieties and species and on interspecific hybridization within the genus *Ribes*, using especially the sub-genus *Ribesia* (the red currants) and certain hardy species closely related to the cultivated black currant, such as

R. dikuscha (see also p. 24). Six interspecific crosses were made in 1956 and others are planned for the coming year.

(M. M. Anderson, W. Fordyce.)

Useful additions were made during the year to the collection of *Rubus* and *Ribes*. Species that we still are anxious to obtain include *Rubus corchorifolius* L. fil. (China, Japan), *R. glaucus* Bentham (Costa Rica, Ecuador), *R. kuntzeanus* Hemsley (Central and western China), *R. macraei* Gray (Hawaiian Islands), *R. macrocarpus* Bentham (South America), *R. rosaefolius* Smith (Brazil, Chile) and *Ribes procumbens* Pallas (Eastern Siberia).

STRAWBERRY INVESTIGATIONS

With the conclusion of two experiments on June Yellows in Auchincruive Climax, our main strawberry work now consists of the trials of new Auchincruive selections conducted co-operatively with the West of Scotland Unit. The 120 selections received in autumn 1955 were too severely checked by the drought that year to produce any useful fruit in 1956, and their assessment at Mylnefield will therefore be delayed. A further 105 selections were received in September and planted as 4-plant units.

(M. M. Anderson, C. A. Wood.)

APPLE VARIETY-ROOTSTOCK TRIALS

These trials, planted in West Laboratory field in 1954, made satisfactory progress except for some minor damage by wind and rooks. The trees on the more vigorous rootstocks at full orchard spacings were again hard-pruned to encourage strong head formation, whereas those in the bush trials on M.IX and M.VII were pruned more lightly and produced a small quantity of fruit. The annual recording of stem girths was begun during the year.

Although the state of the trees did not warrant grassing down, the inter-row areas in the larger trials were sown down in mid-June to protect the soil from wind erosion. Cultivated strips 8 feet wide were left along the rows of trees. The seeds mixture sown per acre was 3 lb. Italian Rye Grass, 12 lb. S50 Timothy, 1 lb. S100 White Clover and ½ lb. Kentish Wild White Clover, which gave a very satisfactory sward by autumn.

(D. W. Burd.)

OTHER VARIETY TRIALS

Red and Black Currants

The new red and black currant variety trials described in the last Report made good growth and should crop in 1957. Further additions to the black currant collection included Scandinavian and North European varieties of interest for breeding.

Plums

By autumn 1956 a total of 28 trees in the 1953 "elimination" trial of plum varieties and rootstocks—about 14 per cent. of the number originally planted —had died following bacterial canker infection. This trial is not statistically designed and its numerical results must be used with great caution; but of the 28 trees, 15 were on Brompton rootstock, 7 on Common Plum and 6 on Myrobolan B. Four of the trees lost on Brompton, however, were of varieties

not represented on the other rootstocks. The losses have included trees of 18 of the 51 varieties on trial: 3 out of 6 trees of Giant Prune and Laxton's Goldfinch have died and 2 out of 6 of Early Laxton, Severn Cross, Gordon Castle Seedling and Count D'Althann's Gage. Most of the healthy trees grew well during the year. Many blossomed for the first time but the fruit-set was poor, due probably to cold and drought during spring. Twelve varieties fruited, represented by 14 trees on Common Plum and 8 on Myrobolan B; none fruited on Brompton. The highest yield was from Laxton's Cropper, but the fruit from all varieties was of disappointing quality. Useful crops were picked for the first time from the gage plums (on Pershore stock) forming part of a shelter row along the west boundary of School field.

Apples, Pears, Cherries

Many interesting records, as well as a considerable output of fruit, are now coming forward from the trees of the Apple Variety Collection on M.IX rootstock. Two hundred and eighty-two varieties cropped in 1956, 177 for the first time, and only 3 of the 91 varieties picked in 1955 failed to fruit again. A fruit exhibit of some 80 varieties was staged at the Dundee Horticultural Society's Annual Show on August 30th and 31st. A further 177 varieties, including many received from Jugoslavia, were added to the collection early in 1957, bringing the total to 679.

In the "elimination" trial of 103 mainly modern apples on rootstocks M.I, M.II, M.IV and M.VII, 85 varieties fruited in 1956. Prominent among these were the Swedish dessert variety Ingrid Marie, with very fine colour, Millicent Barnes with good flavour, and the cooking variety Howgate Wonder, outstanding for size. Some information was obtained on the behaviour of fruit from this trial when stored in a cool room, and selected culinary varieties were supplied to the Ministry of Agriculture, Fisheries and Food's Experimental Factory at Aberdeen for dehydration tests.

The pear collection was transferred in spring 1956 to a new site in West Laboratory field. Thirty-four varieties, including several of local origin, were then added, bringing the total to 62. Most of these are worked directly upon Quince A.

Several trees of the 1955 cherry trial, in the same field, were damaged by the summer gales, but not sufficiently to cause serious damage to the heads.

Scottish Regional Fruit Trials

These trials of raspberries, black currants and plums were continued in co-operation with the Scottish Fruit Trials Committee, to which a report is made annually. The black currant crop was again reduced by frosts and cold weather in spring, though less seriously than in 1955. The raspberry trial (planted in 1952) cropped well: Malling Jewel led in yield with just over 5 tons per acre and the lowest-cropping variety, Malling Enterprise, gave 3.9 tons. Samples of fruit were again used for several processing tests, including for the first time a commercial assessment of raspberry juice flavour.

Results from these trials at the Agricultural Colleges and Mylnefield appeared in further published reports during the year (Hall, J. W. (1956)—*Scottish Agriculture*, **36**, 23-26, 94-98).

(M. M. Anderson, W. Fordyce, J. P. Sutherland, B. Tulloch.)

CHEMICAL WEED CONTROL

Experimental work on the use of herbicides in raspberry plantations and cane nurseries, mentioned in the last Report, was expanded during the year. Although the main attention so far has been given to nurseries, considerable importance attaches to the development of chemical methods of weed control in fruiting plantations, where hand-cleaning along the rows is costly. Experiments during the past two years have been mainly with the phenyl carbamates (IPC and Chloro-IPC), pentachlorophenyl (PCP) and tar oil. Preliminary results have shown that IPC and C-IPC may be of some value in raspberries, but they are not effective against all types of weed and their application must be carefully timed, especially in cane nurseries, if damage is to be avoided. Trials of several new materials are planned for 1957.

(J. P. Sutherland.)

MISCELLANEOUS

Routine measures for pest and disease control in the experimental plantations were arranged in co-operation with Mr Fisken. The glasshouse red spider mite (*Tetranychus telarius*) was again troublesome on raspberries and black currants, perhaps partly because of the use of DDT sprays on these crops early in the season. Raspberry moth larvae were numerous in spring on the older plantations, especially on plots of Lloyd George, despite a thorough routine application of 8 per cent. tar oil to the stools in February.

The almost complete failure of strawberry mildew to develop during the fruiting season followed a special effort made to control it during May and June, when four sprays of 1 per cent. lime sulphur were applied instead of the one or two at 2 per cent. given in previous years. It was unfortunate that, since all the plantations were treated, there was no unsprayed area available for comparison.

PUBLICATIONS

Wood, C. A. (1956). North America wants more good raspberries. *Grower* (Annual Fruit Review), 13th October 1956, 831.

(A popular account of the present position of raspberry production in Scotland and possible future market trends, with a discussion of varieties, information on the availability of stocks for planting and brief reference to experiments at Mylnefield on raspberry cultivation.)

Wood, C. A. and Robertson, Margaret (1957). Observations on the fruiting habit of the red raspberry (*Rubus idaeus* L.) and on an occurrence of cane "die-back" in Scotland. *J. hort. Sci.* **32** (in the press).

(This paper, describing the arrangement and development of buds at raspberry cane nodes, shows that considerably more inflorescence primordia are initiated than normally emerge as flowering laterals. Buds and inflorescences are termed "primary," "secondary" and "tertiary," according to their positions of origin at the node. Laterals are most frequently produced singly at each node, by the main or primary buds only, but may also arise from secondary and tertiary buds, especially where primary buds or their laterals are damaged by, for example, insect pests or frost. Some varieties readily produce secondary laterals and may carry more than one lateral at a node even in the absence of damage, whereas others, when damaged, recover very poorly. A four-year survey of the formation of fruiting laterals included a year (1955) in which an extensive "die-back" of canes and laterals occurred in eastern Scotland, caused probably by winter injury.)

VEGETABLE CULTURE

C. North

Many of the experimental vegetable crops were adversely affected by the unusual weather conditions. During the cold weather of January and February 1956 when there were heavy snowfalls, over-wintering brassica plants suffered severe damage from frost and wood pigeons. The cool summer conditions induced much premature bolting in some stocks of carrot, cabbage and brussels sprout and delayed the maturation of most vegetable crops. Winter-maturing brassicas, however, developed better than had at first been expected because they continued to grow throughout the unusually mild autumn and winter of 1956-57.

Owing to the low yield of straw from the 1955 harvest the compost heap had to be made up to the required amount of 100 tons by adding pig manure. This was chosen in preference to farmyard manure because it does not usually carry the club-root fungus.

VARIETY TRIALS

French Beans

The weather was very unfavourable to the growth of this crop and picking did not commence until August 25th. Record (Ohlsons Enke) started to mature earlier and gave a higher yield than any of the other 8 varieties in the randomised block trial. Its pods were as straight and unblemished as in previous years. Saxa (Rijk Zwaan) and Konserva II/54 (Weibull) gave the highest yields of beans of the entirely stringless type and in this respect were superior to Fullcrop and Processor, both of which had given high yields during the warm summer of 1955. The pods of Saxa were often misshapen and badly blemished, but those of Konserva II were nearly as straight and unblemished as those of Record.

Three new varieties were grown in observation plots. None of these was judged superior to the best of the varieties in the trial but Sabo (Sauer) and Regina (Dippe) were chosen for further trial. The former is very similar in appearance to Processor and the latter resembles a white-seeded form of Saxa.

Broad Beans

Seeds of 35 varieties of broad bean were sown on March 30th. The resulting plants all grew well in spite of the cold weather and complete lack of shelter from wind, and no disease symptoms were observed. The Windsor varieties were more vigorous and mostly gave higher yields per plant than the longpod types. Two stocks of Three-fold White were the only varieties with small seeds of the type generally considered as suitable in Britain for canning and deep freezing.

Canning Peas

The cool weather permitted uniform ripening and it was therefore possible to determine the "Practical Canning Stage" more critically by the alcohol-insoluble-solids test than in 1955. Monarch Canner (Hurst) gave as heavy a crop as the most popular main crop variety, Lincoln. Canners' Perfection again gave a comparatively low yield.

Brussels Sprouts

Harvesting of the trial planted in 1955 was completed during the period covered by this Report. The highest yields of saleable sprouts were given by the strains Cluseed (Clucas), Sanda (Beemsterboer), Castricum Glory (R. Zwaan) and Cambridge Special. These varieties all had medium to dark-green sprouts. Cluseed and Castricum Glory gave sprouts large enough for the green market; those of the other two varieties were rather too small for this purpose, but were of a size suitable for quick-freezing.

Forty-three strains were grown in the 1956-57 observation plots and four of these were selected for further trial. The variety Unicum (Nunhem) had especially firm, dark-green sprouts, and was similar to Sanda and Atlas Slusia.

Summer Cabbage

Plants of 46 strains of summer cabbage were sown and raised outdoors. Some stocks were very variable and gave a high proportion of premature bolters. Extra Early Roundhead (Clucas) and First Crop (Ohlsons Enke) were the most uniform of the earliest-maturing strains. Velocity (Harrison) Primo (Sharpe) and Golden Acre 84 (Ohlsons Enke) were very uniform strains which matured a few days later. Two strains of Canadian Acre (Canadian Department of Agriculture, and Tozer) were also very uniform. The plants had much smaller heads and matured about a week after the latest of the other varieties mentioned here.

(L. Frith, H. Taylor.)

Broccoli

Six stocks selected from the variety Royal Oak by the Scottish Plant Breeding Station were compared in a replicated yield trial. The plants were badly damaged by frost and wood pigeons and many died. One strain gave a considerably higher proportion of marketable heads than the others.

Carrot

Observation plots of 28 varieties were grown. Many of the plants formed premature seed stalks, a rather higher proportion occurring in the Chantenay than the Nantes types. The heaviest individual roots were those of Sweet-crop (see publication list) followed by those of the Chantenay and then the Nantes types. Two American varieties, namely Morse's Bunching (Ferry Morse) and Supreme Half Long (Ferry Morse), had exceptionally dark-coloured and crisp-fleshed roots. The colour of Red-cored Early Market (Hurst), Early Nantes (Hurst) and Early Nantes (Cullen) was also good, but these stocks were less uniform in this respect than the two American varieties.

(L. Frith, G. Priestley, H. Taylor.)

Spinach

Some effects of plant population on the growth of spinach were examined in a randomised-block layout. Seedlings of the variety King of Denmark were thinned to distances of 3, 6, 9, 12 and 15 in. apart in rows 15 in. apart. Plants closely spaced had longer stems and a lower proportion of leaf to stem than those widely spaced. Plants thinned to 6 in. apart gave the highest yield of leaf per plot.

Rows of seedlings in the yield trial were cross-blocked with a "Planet" hoe to leave plants in small clumps one foot apart in the rows. The seedlings were then thinned by hand to leave one from each clump. This technique gave much more uniform plant spacing than in previous spinach yield trials, and simplified the statistical analysis of the results. Verina OJO/53 (Olson) and Noorman (Rijk Zwaan) gave the highest yields, followed by King of Denmark F/50 (Gehlin), Troubadour (Zwaan and de Wiljes) and King of Denmark (Hurst). Three of the varieties grown in observation plots were chosen for inclusion in the 1957 yield trial. One of these, Toftegaard (Hansen), which resembles Verina, was the last of all the tested varieties to run to seed.

(C. North, L. Frith, H. Taylor.)

PLANT BREEDING

Brassicas

Selected F_1 brussels sprout plants derived from crosses between Ashwell's strain, Cambridge Special, Amager and Castricum Glory were self-pollinated by hand in the glasshouse using the bud-pollination technique; 94 per cent. of the pollinated buds developed pods, each containing 20-30 seeds.

F_2 and backcrossed families of brussels sprout from pollinations made in previous years were tested in the field and further plants were selected for yield and sprout quality from the most uniform families. Individual families from selfed sibling F_1 plants often differed considerably in many morphological characters and in strain uniformity.

Material derived from crosses between the cabbage varieties January King, Amager, Blotopp, Danish Keeping and Christmas Drumhead was tested in the field and further plants were selected for pollination in 1957.

(G. Priestley, C. North, H. Taylor.)

Beans

Two generations of the material derived from the cross between *Phaseolus multiflorus* Willd. var. Princeps and *P. vulgaris* L. var. Record were produced in the glasshouse. All plants of the first generation were backcrossed to the *P. vulgaris* parent. Most of the plants from the first backcross generation were allowed to self-pollinate. They were moderately self-fertile although the fertility of individual plants varied considerably. Of the subsequent progeny 63 per cent. were plants of a dwarf habit similar to that of typical dwarf French beans, 30 per cent. were dwarf plants with a tendency to climb and 7 per cent. were climbing plants which grew only 2-3 ft. tall. Although the fertility of all these plants again varied considerably, the population increased tenfold.

Some of the plants derived from the first backcross generation were again backcrossed to *P. vulgaris*. Seventy-nine per cent. of the progeny were plants of a dwarf habit and the remainder were dwarf plants with a tendency to climb. Sufficient seed of the original interspecific hybrid material is now available for testing outdoors in 1957. Further interspecific hybrids were obtained from Record and Fullcrop (*P. vulgaris*, female) and Kelvedon Monarch (*P. multiflorus*, male); the latter was chosen because it is said to mature early. About a quarter of the pollinated flowers gave seed. All the F_1 plants derived from the Record cross and 50 per cent. of those from the Fullcrop cross grew weakly and died without flowering. The remaining 50 per cent. of the F_1 seeds from the Fullcrop cross developed into vigorous climbing plants and flowered.

(G. Priestley.)

VEGETABLES FOR DEHYDRATION

We again co-operated with the Food Division of the Ministry of Agriculture, Fisheries and Food by sending samples of different varieties of cabbage, brussels sprout, pea, bean, spinach and leaf celery to the Experimental Factory at Aberdeen for dehydration tests. The results from leaf celery were especially encouraging. The crop of this vegetable was grown from seed of the common variety (Hansen) sown direct in the open ground on April 19th and left unthinned.

PHYSIOLOGICAL INVESTIGATIONS

During the last three years an attempt has been made to understand how the compacted mass of leaves that forms the head of the cabbage develops.

A high rate of leaf formation and slow growth in length of the main shoot axis seem necessary for head development. However no differences in these two characters can be detected between plants which form a head and rosette-rogue plants which do not. The essential difference between these two types appears to be in the extent to which their leaves remain clasped or folded around the younger leaves. After the earliest stage of growth is passed, the leaves of cabbage plants appear always to be formed in a folded state even in rosette-rogue plants. Some leaves of potential heading plants however fail to unfold whereas all leaves of rosette rogues ultimately unfold.

Defoliation experiments have shown that the innermost leaves of cabbage heads are actually able to unfold. Thus we may deduce that something prevents the unfolding of some leaves in heading plants. An important factor in preventing unfolding seems to be the self-imposed mechanical constriction of the leaves which keeps their margins from becoming free and thus prevents them from unfolding at a stage when they are capable of doing so. This constrictive effect is thought to be cumulative, so that each leaf affects its younger neighbours more than it was affected itself. The formation of very broad leaves might cause such a constriction and it was found that leaves of headed plants are in fact broader than those of rosette rogues. Further support for this hypothesis was given by measurements of leaves from five cabbage varieties that form heads at different seasons. The ratio of length to width was smaller for leaves of early than for those of late maturing varietiess

Preliminary studies of cell expansion in developing leaves were also made, and for this purpose a technique was devised for the rapid measurement of the size of epidermal cells.

(C. North.)

PUBLICATIONS

NORTH, C. (1956). A technique for measuring structural features of plant epidermis using cellulose acetate films. *Nature*, **178**, 1186.

(A coloured solution of cellulose acetate in acetone is painted on the plant organ from which measurements are required. The film dries quickly and after flooding with a solution of detergent may be lifted from the leaf. The film bears an impression of the cells on the surface of the leaf, and when viewed through a microscope it closely resembles epidermal tissue. The technique can be performed rapidly and gives a permanent record from which measurements may be obtained at leisure.)

NORTH, C. (1957). Studies in Morphogenesis of *Brassica Oleracea* L. 1. Growth and development of cabbage during the vegetative phase. *J. exp. Bot.*, **8**, 304.

(Detailed analyses of the growth in weight of cabbage plants under field conditions in Scotland show that, even in the height of summer, plants increase in weight very slowly during the first 60 days: under similar conditions, plants of some varieties are able to reach maximal weight in a further 50 days.

The cabbage head contains reserve sugars and therefore presumably functions as a storage organ. Unlike the well-defined storage organs of the turnip and carrot, however, the leaves comprising the cabbage head do not grow at a much greater rate than the other primary parts of the plant.

The five varieties examined differed in rate of leaf initiation, growth in length of stem, and time of flower initiation, but none of these differences was correlated with sequence of maturation. The time of retardation of leaf unfolding was the only varietal growth characteristic found to be related to time of maturation.)

NORTH, C. and FRITH, L. H. (1956). Variety Trials of Vegetables in Scotland. I. Summer spinach at Invergowrie 1953-1955. *Ann. Rept. Scottish hort. Res. Inst.*, 1955-56, 14.

(Forty-nine strains of spinach were examined. The highest yields were given by King of Denmark (Gehlin) and Verina (O. J. Olson) followed by King of Denmark and Troubadour both from Zwaan and de Wiljes.)

PRIESTLEY, G. (1956). A New Carrot Variety for the Home Gardener. *N.Z.J. Agric.*, **93**, 489.

(The development of a garden variety called Sweetcrop by selection from the New Zealand field variety Holmes' Improved is described. This new variety has has given high yields in replicated yield trials and was considered by 73 per cent. of the housewives who took part in a cooking test to have superior texture and flavour to the average New Zealand market varieties of carrot.)

YEN, D. E. and PRIESTLEY, G. (1956). The selection of cabbage strains for New Zealand conditions. *N. Z. Commercial Grower*, **12**, 5, 1.

(In 1947, a survey of savoy cabbage stocks in New Zealand showed that most of those available at the time were poor. Consequently a programme for the breeding of a "Best of All" type of savoy was commenced by the Crop Research Division, D.S.I.R., Christchurch. After eight years of work a high class stock has been raised and released through the Seedsman's Association.)

CROP PHYSIOLOGY

T. SWARBRICK

THE SEASONAL GROWTH OF PLANTS IN RELATION TO LIGHT INTENSITY AND TEMPERATURE

During the spring and summer of 1956 pot experiments were made, at successive weekly intervals, to determine the effects of seasonal changes in light intensity and temperature on the vegetative growth and development of the sunflower (*Helianthus annuus*, var. Pole Star) and the field bean (*Vicia faba*, *var. equina*). These two species were chosen primarily because the sunflower requires a relatively high temperature for growth while the field bean makes appreciable growth at lower temperatures. It was considered that, by selecting these two species, it would be possible to assess more accurately the relative importance of temperature on plant growth.

Plants of standard morphological status were obtained by making sowings of each species every few days throughout the season. An excess of seed was sown and subsequently the number of plants was reduced to leave the required number of uniform plants per pot. On each sowing occasion a sufficient number of pots was sown to allow a choice of material. At the beginning of each experiment pots were paired; one of each pair was harvested immediately and the other after an interval of one week. At harvest the plants were divided into root, shoot and leaf, and the leaf area was accurately estimated from a leaf sample and the dry weight of the various portions was determined. From these data the net assimilation rate, (increase in dry weight per unit of leaf area, per unit of time) the relative leaf area (leaf area/plant dry weight) and the relative growth rate (increase in dry weight per unit of plant dry weight per unit of time) were calculated.

Continuous records of the temperature and the light intensity, excluding the infra-red and ultra-violet radiation, were made in the experimental area with the instruments described below.

Multiple regression analyses have revealed that the rates of assimilation and growth of *V. faba* were positively correlated with the light intensity but were not significantly affected by temperature. The relative leaf area was not significantly affected by variations in either the amount of light or the temperature. By contrast, in *H. annuus* both the net assimilation rate and relative growth rate were positively dependant on the light intensity and on the temperature. The relative leaf area was significantly depressed by increasing amounts of light but it was not significantly affected by changes in the temperature.

Before any conclusions can be drawn on the effects of changes in the light intensity and temperature on the seasonal pattern of plant growth and development further investigations are necessary, and the series of experiments described will be repeated during the coming season.

(G. L. Hodgson.)

THE CONTINUOUS RECORDING OF LIGHT INTENSITY

During 1956 further efforts have been made to develop reliable instruments for the measurement of light intensity. Although instruments which appear to be suitable are now available it has not been possible with the present facilities and methods to calibrate these instruments accurately. Until calibration methods have been perfected the relative importance of the light factor in the various horticultural areas of Scotland cannot be assessed.

During seventeen weeks of the season records of light intensity were taken from two continuous light-recorders of different design. One of the recorders had been constructed as described by Blackman, Black and Martin (*Ann. Bot. N.S. XVII* **68**, 529, 1953). The other instrument was supplied by the National Institute of Agricultural Engineering, Silsoe, and is fully explained by Trickett and Mousley (*J. Agric. Eng. Res.* **1**, 1, 1956). Throughout the period there was a good correlation between the records obtained from the two instruments despite important differences in their design.

(G. L. Hodgson, J. Cathro.)

THE PHYSIOLOGY OF GROWTH OF THE STRAWBERRY PLANT

Effects of Photoperiod

An experiment made in 1955 showed that vegetative growth was stimulated and flower formation delayed or inhibited in strawberry plants given short photoperiods when they were connected by stolons to other plants exposed to long photoperiods. This result has been confirmed and the transmission of the stimulus from donor (long-day) to receptor (short-day) plants has been studied. By adjusting the photoperiods to include different durations of exposure to daylight, an experiment was made in which movement of assimilates along the stolons might be expected to differ quantitatively in different treatments. The effects of the "vegetative" stimulus were observed in the receptor plants only in the treatment where a large movement of assimilates from donor to receptor plants was likely to have occurred. Evidence supporting the idea that flower-inducing stimuli move in the assimilate stream has been obtained by several workers, and it seems likely that the "vegetative" stimulus in strawberry plants moves along the stolon in a similar way.

Attempts to detect the flow of assimilates along the stolon by a thermoelectric method (Bloodworth, Page and Cowley, 1955, *Proc. Soil Sci. Soc.* 411) failed although this method readily measured the rate of flow of the transpiration stream. Preliminary work with radio-active phosphorus (^{32}P) gave experience in the handling of radio-active materials but the experiments were made too late in the season to give useful results.

(C. G. Guttridge.)

Cold Storage of Strawberry Runners

Experiments have shown that strawberry plants will survive cold storage for a long period. Plants cold-stored from early spring will form flower buds as usual in autumn provided they are planted out not later than July. If planting is delayed until early September no flower trusses are formed in the autumn and the plants are barren the following year. These results extend those of the physiological investigations reported last year. Further investigation is

necessary before practical recommendations can be made but the results suggest that cold storage of strawberry runners for subsequent summer planting might be feasible on a commercial scale. In this way strong runners could be made available to growers interested in summer planting for cropping in the first year. This might be the basis of growing strawberries as an annual crop.

Cultural Practices

In 1956, mowing the leaves of Talisman after harvest hastened flower initiation and increased the total number of flower trusses formed per crown. The effect on yield will appear in the 1957 crop. However, defoliation of maiden plants is undesirable.

An experiment with Auchincruive Climax has shown that the increase in yield that results from post-harvest defoliation is enhanced by cloching the plants during the autumn. A slight improvement in yield also followed the cloching of untreated plants. There are good theoretical grounds for expecting this result from cloching in Scotland since autumn growth is usually insufficient to allow maximum formation of flower trusses. In southern England autumn cloching is unlikely to be advantageous as an extension of the growing period will result in premature emergence of inflorescences which will not survive the winter. Further experiments on the effect of autumn cloching in Scotland are being made.

(C. G. Guttridge, P. A. Thompson.)

Biochemical Investigations

It seems possible that morphological changes in the strawberry plant, induced by changes in the environmental conditions, may be correlated with fluctuations of organic metabolites. For an initial study of this problem, amino acids were chosen because of their key position in the metabolism of the plant and the fact that much is already known about their metabolic roles.

During the year efforts have been made to devise a reliable method of cold extraction followed by paper chromatography by which quantitative and qualitative changes in the amino acid content may be determined.

Results already obtained suggest that both diurnal and seasonal fluctuations occur in the free amino acid content of the strawberry varieties examined. In Climax, an increase in severity of June Yellows symptoms was associated with a large increase in free amino acids, particularly arginine and asparagine.

(P. A. Thompson.)

GENETICS

A. B. Wills

SPRING CHLOROSIS OF STRAWBERRY

Spring chlorosis of strawberry, with special reference to June Yellows, is being studied by observing the behaviour of seedlings from selfs and crosses of strawberry varieties. The varieties chosen were referred to in last year's Report and include Climax, Talisman and Redgauntlet (6J27). The first phase of this programme was almost completed in 1956 and consisted in self-pollinating individual plants of different varieties and making reciprocal crosses between them.

Seed, from pollinations made in spring 1955, was harvested in the summer and germinated in spring 1956. The seedlings were assessed for colour of cotyledons and colour of the first few leaves. Whereas cotyledon colour generally varied little, certain families had occasional seedlings with white cotyledons but all these died without developing true leaves. The colour of the first true leaves varied from dark green to pale green, yellow or white, and at this stage it was found impossible to diagnose June Yellows unequivocally. In one large family of 324 seedlings, obtained by self-pollinating a severely affected plant of Climax, only 5 seedlings could be scored with certainty as showing June Yellows on the first leaf, but by the time 6-10 leaves had developed nearly all seedlings in this family showed typical June Yellows symptoms.

One hundred and sixty-three families were selected from the material produced in 1955. These were planted in the field in September 1956 and will be kept under observation for at least two growing seasons. Families raised in subsequent years will receive similar treatment.

GAMMA-RAY AND NEUTRON IRRADIATION OF BRASSICA SEED

In collaboration with the Technological Irradiation Group of the Atomic Energy Research Establishment, Harwell, seeds of cabbage and brussels sprout were irradiated with varying doses of gamma rays and thermal neutrons up to a maximum of 200,000 rep gamma rays and $9{\cdot}1 \times 10^{13}$ neutrons/cm^2. Four weeks after the irradiated and untreated seeds were sown, the germinated seedlings were counted. Irradiation did not effect germination, but many seedlings from those treated with gamma-rays were blind. Four months after sowing, blind plants had died and the survivors were counted. Neutron-irradiation of the seed slightly reduced the numbers of surviving seedlings of both cabbage and brussels sprout, whereas the largest dose of gamma-ray irradiation reduced the surviving numbers of brussels sprout and cabbage plants to 32 and 1 per cent. respectively. This is a co-operative project between the Genetics and Vegetable Culture Departments and is intended to explore the possibilities of inducing mutations of horticultural value; also, characters usable as markers in breeding material will be sought.

INTERSPECIFIC RIBES CROSSES

Experience at Mylnefield shows that all the commercial varieties of black currant commonly grown in England are subject to frost damage at flowering time when grown in eastern Scotland. By contrast the red currant, although flowering at the same time as the black currant, usually crops well in years when the black currant fails to do so. Experiments have therefore been started to investigate the possibility of combining the frost resistance of the red currant and other *Ribes* species with the fruit characters of the black currant.

Eighty-five black currant flowers pollinated by red currant in 1955 gave no berries but 177 red currant flowers pollinated by black currant gave 11 berries and a total of 77 seeds. In the spring of 1956 four of these seeds germinated giving one apparently normal red currant plant and three extremely dwarf plants. In the spring of 1957 a further 14 seeds germinated from the original sowing and although they are still in a juvenile state only one is obviously dwarf, the remainder tend to the habit of the red currant parent but are of a darker colour. These seedlings seem to be genuine hybrids.

In 1956, further cross-pollinations between red currants and black currants were made with different varieties from those used before. Hybrid seed was produced with both black currant and red currant as the maternal parent.

PLANT PATHOLOGY

C. H. Cadman

SOIL-BORNE VIRUSES

Study of the several distinct soil-borne viruses that have recently been found has shown that these have many features in common. All but one of them occur on light-textured soils in Scotland: indeed, some soils have been found to contain at least three different soil-borne viruses. All of the viruses have a wide natural and experimental host-range, and they are frequently restricted to the roots of plants that grow in virus-containing soil. The viruses differ from each other in symptomatology and properties, and infection with one of them does not protect plants from infection with another.

Raspberry ringspot virus

This virus is the cause of raspberry leaf-curl disease in Scotland and unequivocal evidence has now been obtained that it is soil-borne in raspberry. Raspberry ringspot virus occurs naturally in several common weeds of arable land and rarely also in sugar beet: these isolates of the virus were identified by crossprotection experiments in *Petunia*. The virus is probably perpetuated in various weed plants, and it is present in localities where raspberries have never been grown.

Beet ringspot virus

A soil-borne virus of the ringspot type was previously found in sugar-beet plants. Because its properties somewhat resembled those of raspberry ringspot virus and it occurred in the same fields, the two were not then distinguished. Crossprotection and serological experiments have shown clearly that this is a distinct virus and that it occurs naturally in many species of crop and weed plants, and in many places. Infected plants are often stunted but they may have no obvious symptoms. Sugar beet, potato, turnip, strawberry, oat and wheat plants all become systemically infected with the virus when grown in the glasshouse in virus-containing soil. In potato, beet ringspot virus considerably decreases yield and it is transmitted through the tubers. This virus has never been isolated from raspberry.

Raspberry yellow dwarf virus

As mentioned in a previous Report, a sap-transmissible virus was isolated from diseased Malling Exploit plants grown at Bere Ferrers, Devon; this virus has now been named raspberry yellow dwarf. The leaves of infected plants have yellow markings on the veins, and the plants become stunted and may die. The virus, which is of the ringspot type, is apparently unrelated to the raspberry or beet ringspot viruses mentioned above. Raspberry yellow

dwarf, or very similar viruses, have been found in weed plants from Bere Ferrers, and sugar-beet seedlings became infected when grown in the glasshouse in soil from there.

(B. D. Harrison.)

Ring necrosis viruses

Viruses that produce necrotic rings of various kinds in inoculated tobacco leaves have been isolated from various sources. These sources include the roots of sugar beet, oat and weed plants, and potato, tomato and *Phlox paniculata* shoots. The viruses from sugar beet and tomato were soil-borne. Many of these viruses are not easy to transmit by mechanical inoculation and although they have been transmitted to plants of several species, no host has been found in which they reach a high concentration. The properties of some of the other, more readily transmissible, isolates resemble those of tobacco rattle virus.

(C. H. Cadman, B. D. Harrison.)

RUBUS VIRUS DISEASES

Raspberry

The majority of viruses found infecting cultivated raspberry and other *Rubus* spp. seem transmissible only by aphids and not by sap inoculation. Experiments with *Amphorophora rubi* Kalt., the principal vector, have confirmed earlier work and shown that aphids acquire virus after feeding for 30 minutes or longer on infected plants. Up to 4 hours, infectivity increases with length of acquisition feed but aphids transferred to healthy plants lose infectivity in 4-5 hours. Infective aphids are able to transmit virus to healthy plants in 5 minute feeding periods. Attempts to separate mixtures of viruses by allowing infective aphids to feed for short periods on a series of healthy *Rubus occidentalis* seedlings usually failed because all the raspberry viruses so far examined seem to be transmitted in the same manner by *A. rubi*. These included several undescribed latent viruses and viruses associated with veinbanding, yellows, leaf spot and bushy dwarf diseases.

Further studies on the susceptibility of raspberry varieties to virus infection have shown that they differ greatly in the frequency with which they become infected with veinbanding disease and that individual varieties differ in susceptibility to infection by different viruses. Whereas Lloyd George readily becomes infected with both leaf spot virus and veinbanding disease, Malling Promise and Malling Exploit are more susceptible to the former than the latter and Norfolk Giant is more susceptible to the latter.

Bramble

Grafting experiments showed that plants of the cultivated brambles, Bedford Giant, Ashton Cross, John Innes, Himalaya Giant and Parsley-leaved were all infected with mixtures of viruses that caused severe stunting and necrotic effects on Norfolk Giant raspberry. Viruses were transmitted from plants of all these bramble varieties to healthy *R. occidentalis* seedlings by *A. rubi*. Some of these caused symptoms on the test plants different from those caused by raspberry viruses and are now being studied. When plants

of Ashton Cross, John Innes and Parsley-leaved brambles were infected, by grafting, with latent viruses which cause no symptoms on most raspberry varieties they developed severe stunting and necrosis.

Samples of loganberry from three commercial sources contained no viruses that produced symptoms on healthy plants of Norfolk Giant raspberry, *Rubus henryi* or *R. occidentalis*.

(C. H. Cadman.)

Virus-free stocks

Under the new arrangements with the Department of Agriculture for Scotland for the production and maintenance of virus-free raspberry stocks, cane nurseries of Malling Jewel, Lloyd George, Malling Promise, Norfolk Giant and Burnetholm Seedling have been planted. These stocks have all been produced from heat treated plants. A cane nursery of Malling Exploit has also been established with selected virus-free plants.

During the year some 10,000 canes of Lloyd George, 4,000 Norfolk Giant and 3,000 Malling Exploit were distributed to commercial growers in Britain for propagation under the official Special Stock Certification Schemes. These came from graft-tested stocks, but in 1957-58 a small quantity of virus-free canes of all the leading commercial varieties may become available for the first time.

(J. Chambers.)

STRAWBERRY VIRUS DISEASES

During the year plants of Talisman, Redgauntlet and Seedling 5V322 were tested for their reactions to infection with strawberry viruses 1, 2 and 3 (mottle, yellow edge and crinkle respectively) by grafting to infected Royal Sovereign plants obtained from Dr A. F. Posnette, East Malling. The tests are still incomplete but the results so far suggest that both Talisman and Redgauntlet show severe symptoms when infected with either yellow edge or crinkle viruses. The infected Royal Sovereign plants were poor sources of virus for aphids (*Capitophorus fragariae* Theob.) and better results were obtained using infected *Fragaria vesca* plants.

Attempts were made to transmit viruses from strawberry plants by rubbing inocula, prepared by macerating leaves and roots in neutral phosphate buffer with and without sodium sulphite, to the leaves of various test plants. The sources used were glasshouse plants infected with various unidentified strawberry virus complexes. No transmissions of the usual strawberry viruses were obtained, although tobacco necrosis viruses were isolated from the roots of several plants.

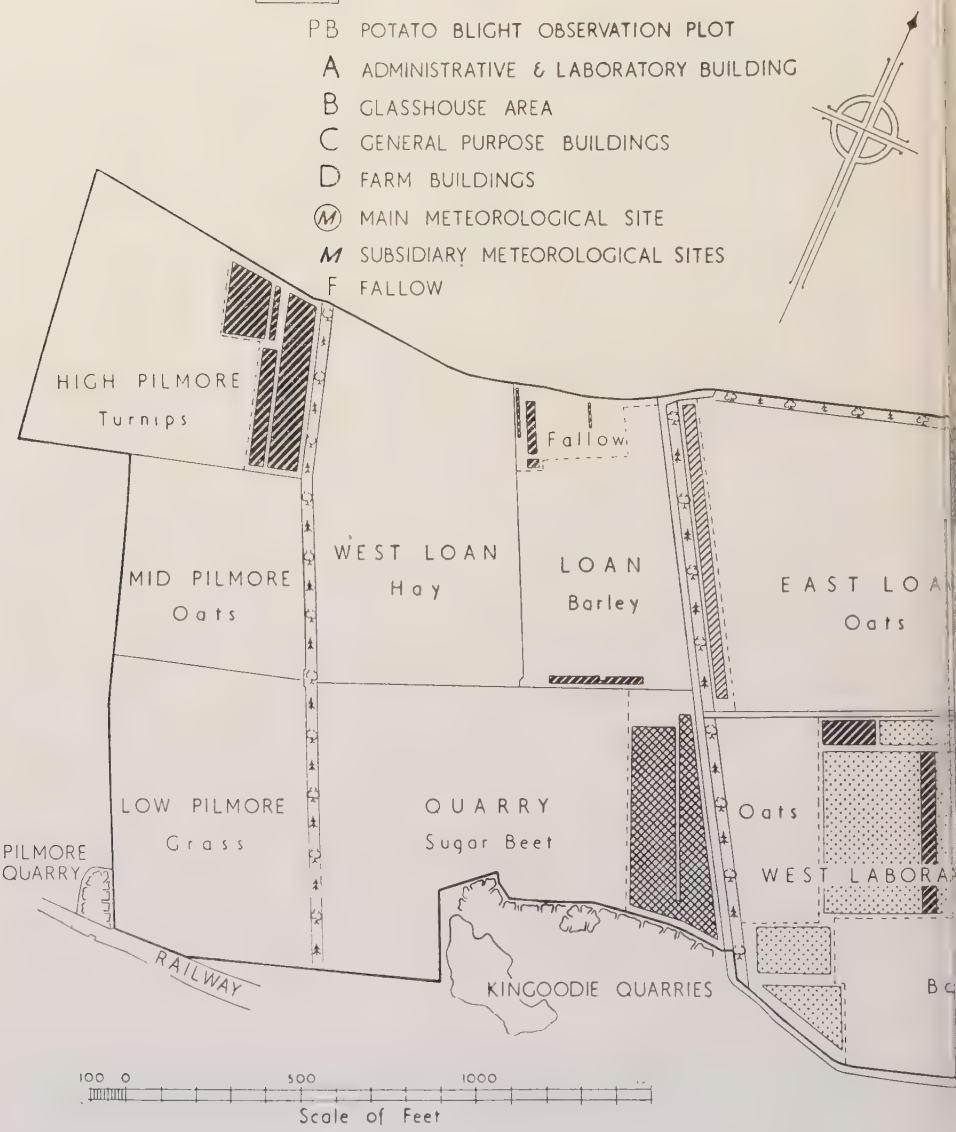
The relationship between phyllody and virescence of clover and other weed plants, and outbreaks of green petal disease in strawberry is being examined. Phyllody in clover has been found commonly in Angus and Perthshire but outbreaks tend to be localised. *Euscelis plebeius* Fall. (det. A. R. Waterston) was the commonest leafhopper collected in areas where clover phyllody occurred and transmitted the virus to red clover in glasshouse experiments.

(R. M. Lister.)

[*Continued on page 30*

EXPERIMENTAL PLANTATIONS 1956

- TREE FRUITS
- SMALL FRUITS
- VEGETABLES
- POTATO VIRUS EXPERIMENTS
- SMALL FRUIT NURSERIES
- GENERAL NURSERY
- MAIN WINDBREAKS
- PB POTATO BLIGHT OBSERVATION PLOT
- A ADMINISTRATIVE & LABORATORY BUILDING
- B GLASSHOUSE AREA
- C GENERAL PURPOSE BUILDINGS
- D FARM BUILDINGS
- (M) MAIN METEOROLOGICAL SITE
- M SUBSIDIARY METEOROLOGICAL SITES
- F FALLOW



SCOTTISH HORTICULTU
MYLNEFIELD
INVE

Areas of Fields

Strip	10¼	Acres
Mid North	13½	"
Lade	8	"
Haugh	4	"
Mill	3	"
Bullion South	40½	"
School	22½	"
Bungalow	15¼	"
Laboratory	8	"
West Laboratory	22	"
East Loan	18¼	"
Loan	8½	"
West Loan	12¾	"
Quarry	17¾	"
High Pilmore	11½	"
Mid Pilmore	7	"
Low Pilmore	10¾	"

RESEARCH INSTITUTE
BULLION
VRIE

DEPARTMENT OF AGRICULTURE FOR SCOTLAND,
ST. ANDREW'S HOUSE, EDINBURGH 1.

POTATO VIRUS DISEASES

Transmission of leaf roll virus

Experiments on the transmission of potato leaf roll virus from infected potato or *Physalis floridana* to healthy plants of *P. floridana* by *Myzus persicae* confirmed the results reported last year. Aphids occasionally acquired virus after feeding for 1 hour on infected plants and on one occasion transmission of virus from diseased to healthy plants was completed in 12 hours. Unless aphids had spent at least 4 hours on infected plants they did not consistently transmit virus to healthy plants during the subsequent 24 hours.

Tests duplicating those recently described in N. America and the Netherlands failed to confirm that transmission of leaf roll virus is effected in less than 2 hours.

(C. H. Cadman.)

Using a technique devised for injecting aphids with minute quantities of liquids, green peach aphids were rendered infective by injecting them with the blood of aphids that had fed on plants infected with potato leaf roll or beet yellow-net viruses. Injected aphids sometimes transmitted leaf roll to test plants within the first day after injection but usually transmission did not occur until the second or third day: aphids transmitted the virus up to 20 days after they were injected. Leaf roll virus was detected in aphids one day after they had begun to feed on infected plants but much more appeared to be present in aphids which had been reared on infected plants. Indications were obtained that potato leaf roll virus did not multiply and accumulate in the bodies of the aphids.

(B. D. Harrison.)

Field spread of Y and leaf roll viruses

In 1955, both viruses spread more in experimental crops at Mylnefield and in field crops in eastern Scotland than in any year since experiments began in 1953. The results of roguing infected plants at weekly intervals from the end of June till mid-August showed that both leaf roll and Y viruses had begun to spread by the first week in July. Extensive spread occurred before the end of July and there was little difference between untreated plots and those rogued after this date. As in previous years, plants adjacent to infectors became infected oftener than those more remote and progenies were often only partially infected.

Twenty-six field crops were sampled in 1955; 5 in the Lothians, 2 in Fife, 4 in the coastal districts of Angus and 15 in the inland parts of Angus and Perthshire. Infector units comprising whole progenies dug from 3 or 5 plants either side of 10 leaf-roll infectors, were grown on in 1956 and these showed that spread of leaf roll had occurred in 25 out of the 26 crops. The single exception was an Epicure crop in Angus grown for ware and lifted in early July. Virus spread most in crops grown in the Lothians, rather less in Fife and coastal Angus and least in inland districts of Angus and Perthshire.

(J. Chambers.)

Potato Aphids

Work during the winter of 1955/56 confirmed that brassica crops, particularly spring cabbage and cabbage grown for seed, are the main overwintering hosts for *Myzus persicae* in eastern Scotland. Peaches under glass seem of minor importance though trees were infested with *M. persicae* at 70 per cent. of the sites visited.

The course of aphid infestation of 48 potato crops was surveyed, 8 of these in co-operation with Mr J. M. Todd of the Scottish Department of Agriculture. Water traps were exposed at Musselburgh, Edinburgh, Cupar (Fife) and at several sites in Angus and Perthshire and electrically operated suction traps at Inveresk and Mylnefield.

The pattern of crop infestation closely resembled that of 1955. Potatoes in the market-gardening area of the Lothians became infested between mid-May and mid-June and by the end of July several crops had populations of 3,000 *M. persicae* per plant. Up to 500 *M. persicae* per plant were found in crops in the coastal strip between Musselburgh and N. Berwick. In Fife, crops became infested towards the end of June and maximum populations of 300 aphids per plant were recorded at the beginning of August. In South Angus, aphids were first found between the end of June and mid-July and in some fields populations reached 300 per plant by the end of August. Crops further inland became infested progressively later in the season and population maxima were smaller. No *M. persicae* was found in the Pitlochry area before the end of July and by mid-September populations did not exceed 25 aphids per plant.

A survey of potato crops in the Moray Firth market-gardening area on August 15th and 16th revealed a situation similar to that found in the Lothians. Crops near to overwintering sites of *M. persicae* had high populations per plant, 540 and 207 in two crops at Elgin, whereas crops more distant were less heavily infested.

Parasites and predators were not abundant this year even on heavily infested crops and had less effect on aphid populations than in 1955.

(A. G. Fisken.)

OTHER VIRUSES

Brassica viruses

Work was started on the viruses causing the yellowing, crinkling and stunting symptoms very commonly seen in crops of yellow turnip in this area. At least three viruses are concerned, among which are turnip yellows virus and turnip crinkle virus, both transmitted by flea beetles (*Phyllotreta* spp.). Together these cause severe stunting in yellow turnip and they also occur symptomlessly in local swede crops.

(R. M. Lister.)

Tobacco mosaic in the tomato crop

In co-operation with Mr T. G. Rubens of the Edinburgh and East of Scotland College of Agriculture, a replicated experiment was done in a commercial, heated glasshouse to test the efficiency of spraying with milk solution in controlling the spread of tobacco mosaic virus in tomatoes. Plants used for the treated plots were rogued in the seedling stage, sprayed at weekly

intervals with milk solution and handled only by workers with their hands wet with the solution. This treatment had little effect on the spread of the virus.

(B. D. Harrison.)

PUBLICATIONS

CADMAN, C. H. (1957). Some applications of virus research to raspberry and strawberry growing. *Proc. 7th Polish National Congress of Horticulture.* (In the press).

(A general account of the modes of spread of raspberry and strawberry viruses and the techniques used to select and multiply virus-free plants.)

HARRISON, B. D. (1956). Soil transmission of Scottish raspberry leaf-curl disease. *Nature*, **178**, 553.

(Plants of Malling Jewel raspberry developed leaf curl disease when planted in soil taken from the site of a disease outbreak. The experiments showed unequivocally that the causal virus, raspberry ringspot virus, is soil-borne and that the soil contained another virus, beet ringspot virus, that seems not to infect raspberry. Both viruses resemble tobacco ringspot and the evidence suggests that viruses of the tobacco ringspot type may commonly be transmitted through the soil.)

MYCOLOGY

W. R. Jarvis

HOST-PARASITE RELATIONS

As part of the study of host-parasite relations in the strawberry red-core disease, the nutrition of physiologic races of *Phytophthora fragariae* was examined. Growth, in culture, of these races was indistinguishable except when certain phenolic compounds, including analogues of strawberry root constituents, were added to the media. In particular, the races differed in ability to use caffeic acid, d-catechin and pyrocatechol. Differences in growth rate of races in the various media could not be correlated with the rate of utilisation of phenols or the rate of appearance of phenolic oxidation and autoxidation products in the media. The physiology of the host-parasite combination, particularly in respect of polyphenol metabolism, is being studied in cultures of excised roots grown in White's medium.

Following the discovery of a seasonal variation in certain polyphenol constituents in strawberry roots, further examination of their polyphenol and ascorbic acid content is being made using material collected periodically. This work has also shown that anthocyanin pigmentation of roots varies greatly both between varieties and seasons. Preliminary analyses showed that there were two main exodermis pigments both differing from the perlargonidin-3-glucoside and cyanidin-3-glucoside found in ripe berries. The effect of these root pigments on *P. fragariae* and their relationship to polyphenol metabolism is being investigated.

AIR SPORA OF RASPBERRY PLANTATIONS

In April, a Hirst automatic spore trap was installed in the main raspberry plantation at Mylnefield and has since been in continuous operation with the orifice 0·5 m. above ground level. Continuous thermohygrograph records are being taken on the site at the same height.

Small numbers of ascospores of *Didymella applanata* and *Elsinoe veneta* were trapped throughout the summer and early autumn, usually when relative humidities above 70 per cent. and temperatures above 12°C prevailed for not less than 12 hours.

The dispersal of spores of *Botrytis cinerea* at fruiting time showed little correlation with macro-meteorological conditions but preliminary results with the Gregory portable spore trap suggest that micro-climatic factors have a major effect on production and dispersal of spores. In commercial plantations, the frequency of fruit picking affected the incidence of grey mould because it affected the number of spore-bearing infected berries; thus in rainy weather the high humidity and cessation of picking usually resulted in an increase in the number of spores in the air.

In co-operation with the Scientific Services of the Department of Agriculture for Scotland, a potato-blight observation plot was maintained at Mylnefield again this year.

WEST OF SCOTLAND UNIT (AUCHINCRUIVE)

R. D. Reid

STRAWBERRY BREEDING

Intensive testing and selection of seedlings for resistance to red core (*Phytophthora fragariae* Hickman) has been continued and a large number of additional crosses made. A complete programme of testing occupies approximately ten years so that, at any given time, the stock of seedlings in hand represents a cross-section of ten years' work.

Initial tests aim to eliminate seedlings highly susceptible to red core. The methods used were described in last year's Report. Seedlings that survive the initial laboratory and field tests and which show promise of horticultural merit are selected for fruiting trials. Runners from them are propagated in clean soil, maintained as a stock reserve in the gauze house and ultimately used to provide runners for subsequent fruiting trials at Mylnefield. Seedlings considered likely candidates for introduction to commerce are graft-tested and virus-free plants selected and propagated. Table 1 summarises the present position regarding material raised during the ten years from 1945 to 1954 inclusive. Table 2 shows the results of testing, by intensive methods, the seedlings raised from crosses made in 1955.

In 1956, 80 crosses were made. These fell into three groups; crosses between selections or varieties with highly desirable commercial qualities, back-crosses with species hybrids and multiple back-crosses. The large quantity of seed obtained in 1956 has been divided into 4 batches and sown at three-monthly intervals between June 1956 and May 1957 in order to spread the testing evenly over the year.

Field resistance to red core

The precise significance of "field resistance," referred to last year, has not yet been ascertained. Table 2 shows that a larger proportion of susceptible seedlings is detected by the laboratory than by the bench method of testing. Field tests show that many seedlings which escape infection in the benches become infected in the field. Some, however, become only lightly infected and remain vigorous. Certain seedlings have consistently shown this "field resistance" for upwards of three years and observations are now being made on runners from them to see whether vegetatively propagated material behaves similarly.

(R. D. Reid, A. M. Sutherland, K. C. McConnell).

Fruiting Trials

Fruiting trials on a fairly large scale were made with the varieties Talisman and the selection which has now been named Redgauntlet. Excellent crops were obtained. At planting distances of 36 in. × 18 in., the crop sold from Talisman was equal to 81.5 cwt. per acre and that from Redgauntlet to 82·5

TABLE 1. Summary of 10 years' breeding for resistance to red core disease

Year of crossing	No. of seedlings raised*	No. of seedlings still under trial (Feb. 1957)	Remarks
1945	1629	7	One undergoing intensive trial with a view to possible introduction.
1946	2849	4	Two varieties, "Talisman" and "Redgauntlet," have been introduced from this group.
1947	1776	4	Of breeding value only, not likely to be introduced.
1948	2648	10	One undergoing intensive trial; others of breeding value only.
1949	478	2	Unlikely to be worth development.
1950	849	8	Under test at Mylnefield and Auchincruive.
1951	3844	128	Under test at Mylnefield and Auchincruive.
1952	7368	225	Under test at Auchincruive and (some) at Mylnefield. Some very promising material in this batch.
1953	1061	21	Mainly of breeding interest; includes species hybrids.
1954	7609	1460	Fruiting as single plant units at Auchincruive in 1957; at present undergoing field test for susceptibility to red core. These include many species hybrids.

*Prior to 1954 lack of proper glasshouse facilities resulted in very heavy winter losses amongst young seedlings in early stage of growth before tests could be applied. Figures quoted refer to seedlings raised to stage where they could be tested.

TABLE 2. Results of testing seedlings raised from 1955 crosses

Method of testing for red core susceptibility	Totals	Discarded for red core infection	Not infected after first test	Discarded for variegation	Dead various causes	Undergoing second test (in field) Feb. 1957
Bench tested in glasshouse. Soil containing mixed inoculum	6910	2436	3569	13	892	
Zoospore suspension dip. Mixed inoculum	2519	2275	117	—	127	
Totals	9429	4711	3686	13	1019	3684

cwt. per acre. The gross crop from Talisman was greater but losses from *Botrytis* fruit rot were in the region of 25 per cent. whereas in Redgauntlet the loss from *Botrytis* was only 10 per cent. The size of fruit in the latter variety was also better maintained throughout the season.

(A. M. Sutherland, K. C. McConnell.)

MYCOLOGICAL INVESTIGATIONS

No further progress was made in 1956 with work on physiologic races of *Phytophthora fragariae*, " field resistance" or with testing of new sources of red-core resistance owing to the infiltration of red core (*P. fragariae*) from some external source, as yet undetermined, to clean stocks of plants awaiting test. It has been shown that the component parts of the potting compost were not responsible for the introduction of infection but a number of other possible sources is still suspect. New methods of culture and propagation of the plants have been evolved and will be tried out this year. Their success will depend on the production of sound root systems and the elimination of risk of infection from external sources.

The nucleus of plants for further work consists of 538 individuals which are believed immune from infection by a physiologic race of *P. fragariae* that infects Huxley but not Climax and Talisman. Of these, 180 have been derived directly from seed collections of *Fragaria* species and are therefore not directly related to the existing red core resistant varieties such as Climax, Talisman and Redgauntlet.

INHERITANCE OF RESISTANCE AND/OR IMMUNITY TO P. FRAGARIAE IN FRAGARIA.

Some of the results obtained during 1956 have had to be disregarded because of contaminations described above. It was possible, however, to self many of the individual plants which had proved immune to the Huxley race already referred to. The results of inoculating the progeny from these individuals with the same race will be available in 1957.

(I. G. Montgomerie.)

JUNE YELLOWS

The main work on this problem is being done at Mylnefield and little further work on the subject has been started here. The results of attempts to re-select green clones of Climax by growing on, as single plant units, a large number of green plants, have not been very encouraging. Out of 162 green sub-clones selected in the winter of 1955/56 only 6 failed to develop mild symptoms of transient yellows in 1956 and these are now being handled as sub-clones for further re-selection.

In earlier Reports comment was made on the incidence of variegated seedlings in numerous progenies. This was most noticeable in 1954, a year in which a considerable amount of seed had been obtained from *Fragaria* species and from imported material. Many of these variegated seedlings were retained to see whether they developed symptoms recognisable as June Yellows when they reached maturity. In the great majority of instances this has not happened and it seems likely that many seedlings which show chlorosis in early life may continue to develop quite normally. By contrast seedlings raised from plants showing authentic June Yellows mostly develop unmis-

takable symptoms of this disorder at an early age. These also occurred among seedlings raised from some varieties not normally regarded as prone to June Yellows, for example, Oberschlesien. The incidence of variegated seedlings in progenies from both 1955 and 1956 crossings has been exceedingly low. Old-established commercial varieties on which June Yellows was observed during 1956 included Western Queen and Cambridge Favourite.

(R. D. Reid, A. M. Sutherland, K. C. McConnell.)

RASPBERRY BREEDING

Selections were made from seedlings raised in 1952 and further crosses made in 1956.

(R. D. Reid, A. M. Sutherland.)

PUBLICATIONS

Reid, R. D. (1956). Talisman: A Progress Report. *The Grower*, **46**, No. 17, October, 1956.

(A report on the performance of the new strawberry variety, Talisman, at Auchincruive in 1956.)

Reid, R. D. (1957). Strawberry breeding at Auchincruive. *Scientific Horticulture*, **12**, 140.

(An account of the strawberry breeding project at Auchincruive and a discussion on some current problems.

METEOROLOGICAL RECORDS 1956

J. SUNDERLAND

Daily meteorological observations were made at 09.00 G.M.T. at the main site. Week-end and holiday observations were done by the glasshouse staff.

In November the main site was inspected by Mr R. W. Gloyne of the Meteorological Office, Edinburgh. His subsequent report was satisfactory but he suggested that we select visibility points at 44 and 220 yards, which has now been done.

Observations were continued on the five other sites established to survey the temperature distribution at Mylnefield and North Bullion.

The results obtained at the main site for the year 1956, compared with those obtained at Auchincruive, are summarized in the following tables:—

MYLNEFIELD—1956

Month	Temperature		Rainfall		Sunshine		Frost
	°F Average Monthly(1)	Deviation from mean (2)	Total inches	Deviation from mean (3)	Total hours	Deviation from mean (2)	Number of days
Jan.	35·3	−2·2	2·73	+0·80	71·6	+21·6	22
Feb.	33·4	−5·1	1·11	−0·74	63·1	−12·9	23
Mar.	40·4	−0·8	1·51	−0·34	116·4	+11·4	13
April	42·8	−2·0	0·81	−0·80	156·3	+16·3	17
May	52·1	+2·7	0·65	−1·34	200·1	+34·1	6
June	53·5	−1·8	2·30	+0·61	164·2	−17·8	1
July	57·7	−1·3	4·06	+1·50	185·0	+31·0	0
Aug.	53·3	−4·6	3·82	+0·55	132·4	−8·6	1
Sept.	54·7	+0·7	4·29	+2·29	64·8	−57·2	0
Oct.	47·5	−0·4	1·09	−1·51	109·6	+14·6	5
Nov.	42·1	+0·4	0·82	−1·50	62·2	−0·8	16
Dec.	41·8	+2·8	2·98	+0·46	17·5	−23·5	11
Year	46·2	−1·0	26·17	−0·03	1343·2	+ 8·2	115

(1) Computed from daily mean of maximum and minimum temperatures at 09·00 G.M.T.

(2) Recorded at official Dundee meteorological station 1921-1950.

(3) Recorded at official Dundee meteorological station 1881-1915.

AUCHINCRUIVE—1956

Month	(1) Temperature (°F)	Rainfall (Total Inches)	Sunshine (Total Hours)	Frost (No. of Days)
Jan.	38·1	2·55	44·3	20
Feb.	34·9	0·95	67·6	23
Mar.	43·8	1·42	128·6	12
April	44·0	0·84	183·6	21
May	51·8	1·76	182·9	3
June	53·5	2·19	182·4	1
July	57·9	5·12	134·9	0
Aug.	53·1	6·35	126·2	0
Sept.	55·7	3·44	78·3	0
Oct.	48·7	3·32	99·2	5
Nov.	43·4	1·19	54·0	9
Dec.	43·1	4·23	18·6	6
Year	47·3	33·36	1300·6	100

Averages for previous years at Auchincruive are not available.

WEATHER SUMMARY

January

Slight snow fell on 10 days of the month. There was a north-east gale on 1st January but there were no very cold days and sun and rain measurements were fairly high.

February

Snow fell on 11 days with a maximum depth of 3·75 inches. Very low temperatures were recorded at the beginning of the month becoming steadily higher towards the end; fairly dry and sunless, with winds light, northerly.

March

Mist and fog persisted for 5 days. Snow fell on 2 days; otherwise dry and sunny. Winds light and variable, becoming moderate, easterly.

April

Fairly dry and sunny but with some hail and snow showers; winds light to moderate, variable.

May

Generally warm, sunny and dry; strong to gale force S.W. winds during the first half of the month. Maximum temperatures of 66°F were recorded on 3 days and 71°F on the 27th.

JUNE

Several days of continuous light rain, becoming warmer later in the month. After a westerly gale on the 2nd, winds moderated to S.W., becoming light and variable.

JULY

Changeable weather with sun and cloud alternating. Thunderstorms occurred on the 1st and 4th, accompanied by heavy rain. Temperatures of over 70°F were recorded on 4 days. Winds moderate to strong, westerly.

AUGUST

Generally cloudy and wet conditions throughout with the highest maximum temperature of 70°F on the 8th. Winds light and variable.

SEPTEMBER

A wet and sunless month with overcast skies and many days of mist and fog. Winds light and variable.

OCTOBER

Cold, dry and fairly sunny. Winds moderate to light, westerly.

NOVEMBER

Fairly warm and little rainfall; persistent cloud at the beginning of the month. Winds light and variable.

DECEMBER

Warm, wet and sunless. Winds increasing from light to strong S.W.

NEW STRAWBERRY VARIETY "REDGAUNTLET"

R. D. Reid

This variety, introduced by the Institute in the spring of 1957, was raised at Auchincruive as a selection from a cross made in 1946. The seed parent was an American seedling, N.J.1051, and the pollen-parent was Auchincruive Climax.

During its trials in Scotland, it was known as 6J27 and in the National Fruit Trials at Wisley, Surrey, and Brogdale, Kent, as Auchincruive No. 25.

The following is a description of the variety:—

Plant: Growth vigorous, upright to spreading; open habit; foliage medium to dark green.

Lamina: Concave.

Leaflets: Slightly longer than broad; surface flat; base slightly rounded and base angle slightly obtuse. Marginal serrations sharp, medium depth.

Petiole: Long; usually green; upper surface flattened; groove shallow; hairs short, outright; petiolule hairs outright. Occasionally bract on petiole.

Stipules: Broad; green, becoming reddish.

Stolons: Numerous, strong, green; hairs short, slightly upright.

Inflorescence: Truss long; flowers protrude beyond foliage. Peduncle fairly long, breaking high; hairs short, slightly upright; ligules fine; pedicel hairs closely upright. Flowers small to medium; complete; anthers plentiful; petals usually seven. Calyx moderately fine; close; medium sized; not deep set.

Fruit: Medium to large or very large; maintaining size well throughout season. Shape round conical; usually very symmetrical but occasionally misshapen. Colour scarlet to crimson, darkening if foliage is scarce. Seeds even and regular, yellow to red; sunken, but fruit not pitted. Plug small and soft; remains in fruit when calyx is removed; little or no cavity. Flesh white suffused red; texture juicy; skin not easily bruised; stands transport well. Flavour sub-acid; only moderate, rather uninteresting.

Presentation of Fruit: Fruit when ripe lies on the ground surrounding the plant, well clear of the foliage. This very characteristic habit of presenting the fruit facilitates picking and appears to reduce liability to *Botrytis* rot, but makes strawing or similar protection highly desirable.

Season of Ripening: Season of ripening, as in all varieties, varies somewhat according to circumstances, but in general is about a week earlier than that of Talisman or Climax. On some occasions it has ripened at the same time as these varieties.

Diseases:

Red Core: Redgauntlet is resistant to some of the ordinary races of *P. fragariae* but is less resistant than Talisman to some of the specialised races which attack existing resistant varieties such as Climax.

Virus Diseases: No exact information is yet available on reaction to virus diseases, but when grown in close proximity to heavily infected stock has been found to develop severe symptoms of yellow edge.

The stock distributed was propagated from virus-tested plants but is being released under a Standard Certificate. If the variety finds commercial acceptance periodic issues of Special Stocks will be made.

VARIETY TRIALS OF VEGETABLES IN SCOTLAND

II. STRINGLESS TYPES OF DWARF FRENCH BEANS: INVERGOWRIE 1954-1956

C. North and L. H. Frith

The French bean (*Phaseolus vulgaris* L.) is intolerant of low temperatures and as a field crop in Scotland it gives a very poor yield, or fails entirely, during a cold season. Varieties, however, differ in their ability to withstand low temperature. Those most commonly grown in Britain have pods which quickly become "stringy" and must therefore be picked when they are still quite young. Such varieties are chosen mainly because they have a reputation for being especially adaptable to adverse weather conditions. Stringless podded varieties, which are edible up to a very late stage of development, are preferred in America and many European countries. The pods of these sorts require very little preparation for cooking and, unlike the "stringy" types, many of them are acceptable for canning and quick-freezing. Most of the stringless varieties however give low yields and, under some conditions, short, curled pods which are of unattractive appearance and therefore not favoured for marketing fresh. This paper describes the testing of 43 varieties to find those that can be relied upon to give a good yield of stringless, and attractive-looking, green pods in Scotland.

Method

Land used for the trials was a deep loam in a site with no shelter from strong winds. It was well-limed and treated with 6 cwt. per acre of a balanced fertilizer before sowing. No bulky manure was used.

During each of the four years, varieties were grown in small-scale observation plots consisting of single rows 12 ft. long. The plants were thinned to stand 12 in. apart in the rows. Varieties for inclusion in a yield trial were selected from the observation plots primarily for earliness of maturation and lack of stringiness of the pods, and secondarily for the appearance of the pods.

The yield trials conducted in 1954, 1955 and 1956 were designed as randomised-block layouts with five replications the first year and subsequently six replications. Each plot had four rows 33 ft. long spaced 15 in. apart, and there was a single guard row round the outside of each trial.

Seed was sown during the third week in May. It was planted about 1 in. deep in drills made with the plough attachment to a "Planet" hoe, and the land was firmed after planting by treading along the rows. The seedlings were singled to stand 12 in. apart in the rows as soon as the first two true leaves had expanded on most of the plants. Harvesting was commenced when the earliest-maturing plants had pods suitable for marketing, and thereafter the

pods were picked every two or three days. These were weighed, measured and examined for stringiness, colour, shape and blemishes.

Varieties Tested

The following varieties were grown in observation plots:—Arla, Black Prince, Burpee's Stringless, Canadian Express, Canadian Wonder, Carlot Favorit, Contender, Double Princess, Early Warwick, Everbearing, Fiskeby, Fullcrop, Fullgreen, Full Measure, Furore, Giant Stringless Greenpod, Goliath, Granda, Konserva, Konserva II, Landreth's Stringless, Landskrona, Masterpiece, Negro Early Fourtyfold, Ne Plus Ultra, Nimbus, Ohlsenia, Perpetual, Premier, Processor, Ranger, Record, Refugee (Idaho Strain), Regina, Sabo, Saxa, Servus, Tendergreen, Tenderlong, The Prince, The Wonder, Wagenaars (stringless), Widusa.

Seven varieties were selected for inclusion in a yield trial in 1954 and two other varieties were subsequently added to these. Both Masterpeice and Refugee were grown in the trials as a basis for comparison; the former because it is the most popular market variety in Britain and the latter because it is the only dwarf French bean at present grown to any extent in England for canning.

Results of Yield Trials

Table 1 shows the yields of pods and the dates of first and last picks, together with the time of commencement of harvesting.

TABLE 1. French Bean Yield Trial 1954-1956

Variety	Yield as percentage of that of Masterpiece			Date of commencement of Harvest		
	1954	1955	1956	1954	1955	1956
Record OE/54 (Ohlsons Enke)	107	82	109	18/8	2/8	21/8
Masterpiece (Cullen)	100	100	100	18/8	2/8	21/8
Saxa (R. Zwaan)	77	85	97	23/8	2/8	21/8
Konserva II/54 (Weibull)	—	—	75	—	—	21/8
Double Princess	90	—	57	1/9	—	27/8
Fullcrop (Hurst)	46	66	34	31/8	2/8	25/8
Fiskeby (Daehnfeldt)	72	83	67	23/8	4/8	21/8
Processor (Ferry Morse)	—	92	4	—	6/8	25/8
Refugee (Hurst)	3	105	3	6/9	25/8	13/9
Least significant difference (P=0·05)	17	8	10			
Yield of Masterpiece converted to cwt. (per acre)	40·0	92·5	66·9			
Sowing Date				19/5	12/5	14/5
Last picking date				16/9	1/10	8/10

No figures are shown for Double Princess in 1955 because the seed of this variety germinated poorly and the resultant plant population was very low.

There was considerable variation in the order of yield during the three years as a result of differences in summer weather conditions. The summer of 1954 was slightly cooler than usual and a frost on September 18th terminated the growth of the plants early. In 1955, the temperature during June, July and August was nearly 2°F higher than the average for these months and late-maturing varieties developed fully. The summer of 1956 was abnormally cool, but in the mild autumn weather the plants continued growing longer than in the previous two years.

Excluding Masterpiece and Refugee, the main characters of the pods of the varieties grown in the trial were as follows:—

RECORD

Very good general appearance; bright green; unblemished and straight, even in cold weather; medium length, broadly oval in cross-section and fleshy; not entirely stringless, but slightly better in this respect than Masterpiece.

SAXA

Poor appearance; bright, rather yellowish-green; very frequently curved and blemished; rather short in length and broadly oval in cross-section; stringless.

KONSERVA II

Good appearance; rather pale colour; generally straight and unblemished; medium length, broadly oval in cross-section; seed generally white but sometimes becoming faintly flecked with mauve when fully ripe; stringless.

DOUBLE PRINCESS

Poor appearance; pale green; often curved, knobbled and blemished in cold weather; short and narrowly oval or flattened in cross-section; stringless and very brittle; seed white.

FULLCROP

Fairly good appearance; pale green; generally curved and with little pod blemishing; medium length and broadly oval in cross-section; stringless but tends to be watery.

FISKEBY

Rather poor appearance; mid green colour sometimes with faint purple flecks which disappear when the pod is cooked; generally misshapen and curved, little pod blemishing; medium length, oval in cross-section; stringless.

PROCESSOR

Good appearance especially in warm weather; dark green; straight or slightly curved; medium length and broadly oval in cross-section; seed white; stringless and brittle.

Many of the stocks were infected with seed-borne diseases, but because of the difficulty in identifying the causes no regular records were kept of their incidence. It was noted however that the pod blemishes, chiefly caused by wind damage, were often associated with attacks of anthracnose (*Colletotrichum lindemuthianum*) in Saxa.

Conclusions

The results confirm that Masterpiece is justifiably considered as a reliable, high-yielding variety for Scottish conditions. Refugee, however, gave very poor yields during the cool summers of 1954 and 1956 and appears to be quite unsuitable for growing in Scotland on a field scale.

The variety Record, from J. E. Ohlsens Enke AB., Copenhagen, Denmark, is of exceptionally good appearance and can be relied upon to give a high yield in Scotland because it matures very early. During an average year it is likely to yield as well as Masterpiece and in Sweden (Nilsson, 1949) it has outcropped this variety, but in warm summers the yield may not increase to the same extent as that of some other varieties because its cropping season is short. In Denmark (Henriksen, 1954) it gave a high proportion of diseased pods, but in the trials described here it was found to be comparatively free from disease. It should prove an excellent sort for private gardens, especially in cold districts, and would probably be well-accepted for the green market in spite of the fact that its pods are much shorter and broader than those of the well-known variety Masterpiece. It might be suitable for canning and quick-freezing, provided the crop is picked frequently.

Of the entirely stringless-podded varieties Saxa gave the highest yield and is suitable for quick-freezing (Hirst and Adam, 1955). The pods were often misshapen and blemished and for this reason Saxa is only likely to be acceptable for processing as sliced beans. The pods are probably too unattractive for the green market. According to the trial results and the description of the variety by Banga (1956), it is particularly susceptible to damage by anthracnose.

Konserva II gave a good yield during the one season it was grown—a cold summer—and the pods were of good quality. It promises to be a suitable variety to grow in Scotland for canning whole, but like the ordinary Konserva its pods are probably too pale for quick freezing. It may also be of value as a high-quality bean for private gardens and the hotel trade. Konserva II is a new variety from W. Weibull AB, Landskrona, Sweden. It derives from a cross between the two German varieties Konserva and Heinrich's Giant (Lamm, Tometorp and Åvall, 1955) and is said to be resistant to anthracnose.

The other varieties grown in the trial are unlikely to give sufficiently high yields and form too misshapen pods to be of value for general cultivation in the field under Scottish conditions. It should be noted, however, that all varieties were grown without any protection from strong winds which are especially damaging to this crop. Under sheltered conditions in walled gardens or under cloches some of the other varieties would be worth growing, especially the high quality Processor (Ferry Morse Seed Company, Cali-

fornia, U.S.A.). This variety is very similar to one available in some European countries under the name Sabo.

REFERENCES

Banga, O. (1956). 8e Beschrijvende Rassenlijst voor Groentegewassen. *Inst. voor de Veredeling van Tuinbouwgewassen, Wageningen.*

Hirst, F. and Adam, W. B. (1955). Varieties of vegetables for quick-freezing. *Tech. Comm. No.* **9**. *Fruit and Vegetable Canning and Quick-freezing Research Establishment, Chipping Campden.*

Lamm, R. Tometorp, G. and Åvall (1955). Klassificerande sort—och stamförsök med köksväxter 1952-1954. *Medd. Trädgårdsförs. Alnarp, No.* **90**.

Nilsson, F. (1949). Lokala sortförsök med bryt —, skär-och vaxbönor 1938-1947. *Medd. Trädgårdsförs. Alnarp, No.* **52**.

Henriksen, A. (1954). Forsøg med sorter af lave, grønne bønner 1949-51. *Tidskr. Planteavl*, **57**, 281.

VARIETY TRIALS OF VEGETABLES IN SCOTLAND

III. BRUSSELS SPROUTS: INVERGOWRIE 1952-1957

C. North and L. H. Frith

The yield of a brussels sprout crop is probably more dependent than that of any other vegetable on the choice of a suitable strain of seed. The trials described here were therefore the first of the series of vegetable variety trials started at the Scottish Horticultural Research Institute in 1952. Although the trials were designed to compare the yield of different strains, special attention was also given to the recording of the quality of the sprouts, both for the green market and for processing. The results have been analysed to find whether yields of saleable sprouts depend more on the formation of a large total weight of side shoots per plant than on those characters which make the sprouts unmarketable, such as susceptibility to rotting, frosting, and "blowing." This information should be useful in the breeding of high yielding strains for Scottish conditions.

Method

All the trials were grown at Invergowrie. The climate here is typical of the areas of Angus, East Lothian, Midlothian, Perth and Fife, where over 95 per cent. of the Scottish-grown brussels sprouts are produced. Land used for the trials was well-drained medium loam in good heart. It was manured with 15 tons per acre of dung, or, during the last two years, with composted straw; the latter was used because it is unlikely to carry the club-root fungus. After ploughing in the dung or compost, the land was dressed with ground limestone. Four cwt. per acre of a balanced fertilizer was broadcast over the trial areas a few days before planting.

Seed was sown outdoors during the second or third week in March. The seed bed was treated with DDT dust to control flea beetles. Plants were transplanted when they were about 3 in. high. Their roots were dipped, immediately after lifting, in a mud slurry of local soil mixed with a 0·01 per cent. Dieldrin solution, and they were set in the field before the "puddle" dried; this treatment (Fisken, 1955) gave good control of cabbage root fly. Planting was done by hand, one person making a slit in the ground with a spade and another placing the roots of the plants in the slit and then firming the soil against them with his foot. Nearly all the plants rapidly became established when this technique was used, even in dry weather, but 0·5-1·0 per cent, had to be replaced because they were pulled up by rooks and crows. As soon as the plants were well established they were sprayed with parathion or metasystox preparations to control aphids.

Each trial was a randomised-block layout with six replications. In each replication there were two rows of 32 plants spaced 2½ feet square as is cus-

tomary in Scotland. Plants at the end of each row were left unpicked. There were single guard rows around the outside of the trials.

Each crop was picked twice only, in October and early March. Harvested sprouts were graded as (1) first grade; firm and unblemished: (2) second grade; moderately firm and unblemished: (3) unsaleable; loose, rotten or frosted. Size, firmness and colour of the sprouts were recorded.

Varieties Tested

The original choice of varieties for inclusion in the 1952/53 trial was made on advice from the National Institute of Agricultural Botany. In later trials some other strains were substituted or added. The varieties were selected for the trials from the following 69 strains grown in observation plots at Invergowrie:—Amager (4 strains); Ambassador; Ashwell's strain; Atlas; Barendrecht Glory; Best of All; Bredase; Bredase groene; Cambridge No. 1; Cambridge No. 3; Cambridge No. 5; Cambridge Special; Castricum Glory; Climax; Collingwood; Column (2 strains); Danish Giant; Dalkeith (3 strains); Darlington; De Rosny; Dwarf Early; Evesham Special; Fancy Most; Feltham Long Standing; Giant Late Crop; Goliath; Harrison's Freezer; Huizer; Improved Ormskirk Giant; King Pin; Lancastrian; Lancashire No. 1; Late King; Long Island, Catskill strain; Masterman; Masterpiece; Mid-season Compact; New Giant, Improved; Octrooi; Odense Market; Precoce de Fontenay; Premier; Red strain; Roodnerf (2 strains); Rous Lench; Sanda; Solidity; Standard (2 strains); The Canner; The Cluseed; Triumph; Unicum; Universal; Vanguard; Wearmouth; Westlandse (3 strains); Wilhelmsburger; XXX.

In addition to these seedsmen's named varieties, three home-selected strains from Scottish growers, and seven unnamed strains bred by Professor R. O. Sherrard of Albert College, Dublin, were included either in the observation plots or yield trials.

Results

I. Yields—The yields of marketable and first grade sprouts of those varieties grown in the trials are given in Table 1; they are expressed as percentages of the weight of marketable sprouts of the control variety Cambridge No. 1 for the respective year. Figures in heavy type are the two or three highest yields for the year, according to the number of varieties under trial.

II. Sprout characters—Size, firmness and colour of the first grade sprouts from four of the trials are given in Table 2; none of these characters was recorded in the 1952/53 trial. The size measurements are averages for 180 sprouts, equal numbers of which were taken from each replicate in the trial and two measurements were made of each sprout. Firmness (D), was calculated from the formula—

$$D = \frac{\text{Wt. of 50 sprouts in oz.}}{(\text{Mean diameter of sprouts in inches})^3}$$

It is thought that this figure fairly represents density because sprouts which felt markedly firm or loose gave correspondingly high and low figures for D. The assessment of firmness by this method however is slow, and it would be an

TABLE 1. Yields of Brussels Sprouts Trials

Yield given as percentage of total yield of marketable sprouts of Cambridge No. 1

Variety (In order of average yield)	Saleable Sprouts										First Grade Sprouts (Both picks)			
	(Both picks)					(2nd pick only)								
	1952	1953	1954	1955	1956	1952	1953	1954	1955	1956	1953	1954	1955	1956
The Cluseed (Clucas)	—	—	**119**	**118**	**133**	—	—	**50**	**11**	**40**	—	**66**	69	49
Sanda (Beemsterboer)	—	—	—	**127**	117	—	—	—	**21**	**42**	—	—	**95**	**73**
Cambridge Special	—	108	**114**	118	**132**	—	**18**	37	8	38	**68**	**76**	**96**	**74**
Atlas (A. Sluis)	—	—	—	106	**124**	—	—	—	**19**	**47**	—	—	81	**78**
Masterman (Finney)	**115**	**116**	**110**	—	—	**27**	14	**41**	—	—	46	41	—	—
Castricum Glory (R. Zwaan)	—	—	—	**122**	105	—	—	—	9	36	—	—	**95**	65
Evesham Special (Tozer)	**122**	**115**	98	112	113	27	**15**	**43**	9	36	**55**	46	67	39
Grower B's	—	—	—	90	117	—	—	—	3	32	—	—	49	35
Cambridge No. 1	100	100	100	100	100	20	11	31	1	21	50	53	77	40
Ashwell's	85	95	81	—	—	**32**	**18**	40	—	—	50	38	—	—
XXX (Harrison)	73	107	81	—	—	15	10	33	—	—	36	27	—	—
Grower A's	—	—	—	47	66	—	—	—	3	22	—	—	11	10
Sig. diff. (P=0·05)	17	7	13	13	13	8	3	3	4	6	7	11	17	10
Marketable Yield of Cambridge No. 1 (cwt./acre)	73·3	109·5	53·5	45·6	68·5	—	—	—	—	—	—	—	—	—

TABLE 2. Sprout Characters

Variety (In order of average yield)	Size (Mean diam. in inches)				Firmness D.				Colour			
	1953	1954	1955	1956	1953	1954	1955	1956	1953	1954	1955	1956
The Cluseed	—	1·41	1·33	1·27	—	136	154	**211**	—	6	**7**	5
Sanda	—	—	**1·18**	**1·16**	—	—	**184**	**218**	—	—	**8**	**8**
Cambridge Special	**1·25**	1·26	**1·21**	**1·18**	**159**	**163**	**186**	**227**	**7**	6	**7**	**7**
Atlas	—	—	**1·21**	**1·21**	—	—	**164**	206	—	—	**8**	**8**
Masterman	1·56	1·51	—	—	127	140	—	—	4	4	—	—
Castricum Glory	—	—	1·26	**1·24**	—	—	158	194	—	—	**7**	**7**
Evesham Special	1·54	1·36	1·34	1·37	129	146	155	171	6	5	5	6
Grower B's	—	—	1·36	1·37	—	—	138	173	—	—	5	5
Cambridge No. 1	1·56	1·42	1·34	1·29	130	166	150	206	4	5	5	5
Ashwell's	1·44	1·33	—	—	**138**	**154**	—	—	**9**	**8**	—	—
XXX	1·48	1·47	—	—	123	126	—	—	**7**	**7**	—	—
Grower A's	—	—	**1·23**	**1·23**	—	—	144	165	—	—	6	6

Heavy-type figures denote sprouts which are exceptionally small (1·25 in. or less in diameter), firm, or dark coloured.

advantage to have some more rapid method of assessing this quality. Consequently the relationships between D and other measurements were determined, and it was found that figures for three of the four years gave significant (P=0·05) correlations between D and the percentage first grade of total marketable sprouts. It therefore seems probable that this last-mentioned percentage is likely to give an indication of sprout firmness in most years.

Colour of the sprouts was judged on samples taken from each replicate in the trial and the figures in Table 2 are means of six estimations taken to the nearest whole numbers. Samples were scored from 1-10, the highest number denoting the darkest colour.

Table 3 gives the percentage of all sprouts with any external signs of rotting or frosting expressed on a weight basis. These figures show that the proportion of rotten sprouts was fairly constant from year to year and that there seem to be varietal differences in susceptibility to rotting. Figures for frosting were usually higher than for rotting, and fluctuated considerably, reaching the high average of 25 per cent. in the very cold winter of 1955-1956. There were no consistent varietal differences in degree of frosting.

Discussion and Conclusions

The five trials fall roughly into two overlapping series. In the first series (1952-1954) the varieties Masterman, Ashwell's, XXX, Evesham Special and

TABLE 3. Percentage of Total Yield of Sprouts (Unmarketable and Marketable) Rotted and Frosted

Variety	Rotten				Frosted			
(In order of average yield)	1953	1954	1955	1956	1953	1954	1955	1956
Cluseed	—	4·3	5·0	10·7	—	**14·3**	25·7	**1·3**
Sanda	—	—	3·7	6·5	—	—	24·5	1·2
C. Special	**7·8**	**7·8**	**9·4**	**11·5**	6·4	**14·1**	23·8	1·1
Atlas	—	—	3·9	8·1	—	—	**28·1**	**1·3**
Masterman	**7·1**	**7·1**	—	—	6·9	11·4	—	—
Castricum Glory....	—	—	7·2	8·5	—	—	24·9	**1·5**
Evesham Special	6·2	5·5	4·6	6·7	**8·2**	12·0	26·4	1·2
Grower B's	—	—	5·6	7·6	—	—	**26·8**	0·8
Cambridge No. 1	5·7	6·9	**9·6**	**12·6**	**13·9**	12·8	15·4	1·2
Ashwell's....	2·2	4·3	—	—	6·6	11·3	—	—
XXX	3·4	5·7	—	—	6·6	6·6	—	—
Grower A's	—	—	5·6	3·6	—	—	**30·6**	1·0
Significant diff. (P=0·05)	2·2	2·4	1·4	7·5	2·3	2·8	2·7	0·9
Mean per all vars.	5·4	5·9	6·1	8·4	8·1	11·8	25·1	1·2

(Heavy-type figures denote 2 or 3 highest figures for the year)

Cambridge No. 1 were compared, and in the second (1954-1956) Sanda, Atlas, Castricum Glory, two growers' strains, The Cluseed, Cambridge Special were compared with the control varieties Evesham Special and Cambridge No. 1. The first three Dutch varieties in the second series, and the growers' strains were grown for two years only.

All the varieties in the first trial series have been tested by the National Institute of Agricultural Botany at a number of centres in England (Finch, 1954) and their comparative yields in these trials were much the same as at Invergowrie. In Scotland, as in England, Evesham Special and Masterman gave higher, and Ashwell's and XXX, lower yields than the control variety Cambridge No. 1, but the differences were not always significant. Evesham Special had darker and more attractive-looking sprouts than the other high-yielding varieties, but they were neither so dark nor so firm as those of Ashwell's strain.

All varieties in the second trial series outyielded the control, Cambridge No. 1, except Grower A's strain. Cluseed, Cambridge Special and Sanda gave consistently higher yields (except Cambridge Special in 1953/1954) than Evesham Special, which was probably the best variety included in the first trial series, although the differences were not always significant. The quality of the sprouts of these three varieties was as good as, or better than, that of Evesham Special, and both Sanda and Cambridge Special gave significantly higher yields of first grade sprouts than either Evesham Special or Cambridge No. 1 on all occasions. The varieties Atlas and Castricum Glory produced high quality sprouts, but their yields, relative to Cambridge No. 1, varied considerably during the two years they were grown.

Thus four of the strains can be singled out by their high yield of good quality sprouts as being especially suitable for growing in Scotland. They may be described as follows:—

Evesham Special. (Strain from A. L. Tozer, Ltd., Pyports, Cobham, Surrey).

A fairly uniform strain giving medium-height plants with large, dark blue-green leaves on short petioles, which are frequently tinged with purple. Sprouts are of medium size, more or less spherical, firm, dark-green in colour and with a covering of somewhat puckered leaves. A good strain for the green market.

The Cluseed (J. L. Clucas Ltd., Ormskirk, Lancs.)

A fairly uniform strain with tall plants which have a tendency to fall over. Leaves large, medium green colour and with short petioles. Sprouts of medium size, ovoid shape, fairly firm and fairly dark, bright green colour and with a moderately smooth outer leaf covering. A good strain for the green market.

Cambridge Special (Sealed-bag Seed, obtainable from many seed firms).

Bred by Mr D. Boyes of the former Horticultural Research Station at Cambridge. A fairly uniform strain. Height medium to short. Leaves small, spoon-shaped and often held upwards on long petioles which are fre-

quently tinged with purple. Sprouts small to medium in size, extremely firm, dark green and with a smooth outer leaf covering. The sprouts grow very close together on the stem, and are thus difficult to pick. There is a marked tendency to rotting and the sprouts must therefore be harvested frequently to avoid tainting of the sample. A very reliable high-quality variety for the garden, also suitable both for the green market in areas which do not demand large sprouts, and for processing. It has been tested for quick-freezing by the Canning and Quick Freezing Research Association, and although the flavour was considered strong, it was thought to be worth further trial (Hirst and Adam, 1955).

Sanda (C. Beemsterboer, Warmenhuizen, Holland).

A uniform strain giving medium-height plants with rather small, dark green, leaves on long petioles. Sprouts well-spaced, small to very small, extremely firm, very dark green and with a smooth outer covering. A high-quality variety which is probably especially suitable for quick-freezing, and also of value for gardens. The sprouts are too small for the green market and tend to fall through the mesh of most sprout nets.

These recommendations apply only to the particular strains of the varieties grown in the trial; stocks from different sources may give different results. Moreover it should be noted that the crops were always grown from spring-sown plants. The recommended varieties may give less satisfactory results when sown in the autumn.

None of the medium to large-sprouted varieties (*i.e.*, sprouts greater than 1·25 in. diameter), such as are suitable for the average green market, gave consistently high yields with high sprout quality; this was true of both seedsmen's and grower's strains. It seems likely however that some of Professor Sherrard's varieties may combine these qualities, but sufficient evidence is not yet available to confirm this view. Nevertheless it is clear that there is still room for the breeding of a high-yielding variety of high quality to grow in Scotland for the green market.

Varietal differences in yields of saleable sprouts depend on the relative weights of side shoots which the plants produce and the proportion of these shoots which are rendered unmarketable because they are rotten, frosted or blown. There were no consistent varietal differences in the degree of frosting from year to year so that this cause of loss of marketable sprouts cannot be the main reason for varietal differences in marketable yield. Neither did differences in amount of rotting play an important part in determining yield for, from Table 3 it may be seen that, although they were significant, losses caused by this factor were always small. There were clearly varietal differences in the degree of "blowing" but these were not closely related to varietal yield. The relative yield of tested strains was, however, very closely correlated with the actual weight of side shoots. This fact suggests that to breed high-yielding varieties most attention should be given to the selection of strains which give the greatest weight of side shoots rather than those which give the least waste. It also points to the increase in yield which might be obtained through increased vigour due to heterosis.

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REFERENCES

Finch, C. G. (1954). Brussels Sprouts variety trials 1949-53. *J. Nat. Inst. Agric. Bot.*, **8**, 100.

Fisken, A. G. (1955). *Ann. Rept. Scottish Hort. Res. Inst.* 1954-1955, p. 27.

Hirst, F. and Adam, W. B. (1955). Varieties of fruit and vegetables for quick-freezing. Summary of 1953 and 1954 trials. *Canning and Quick Freezing Res. Ass. Tech. Mem. No.* **9**.

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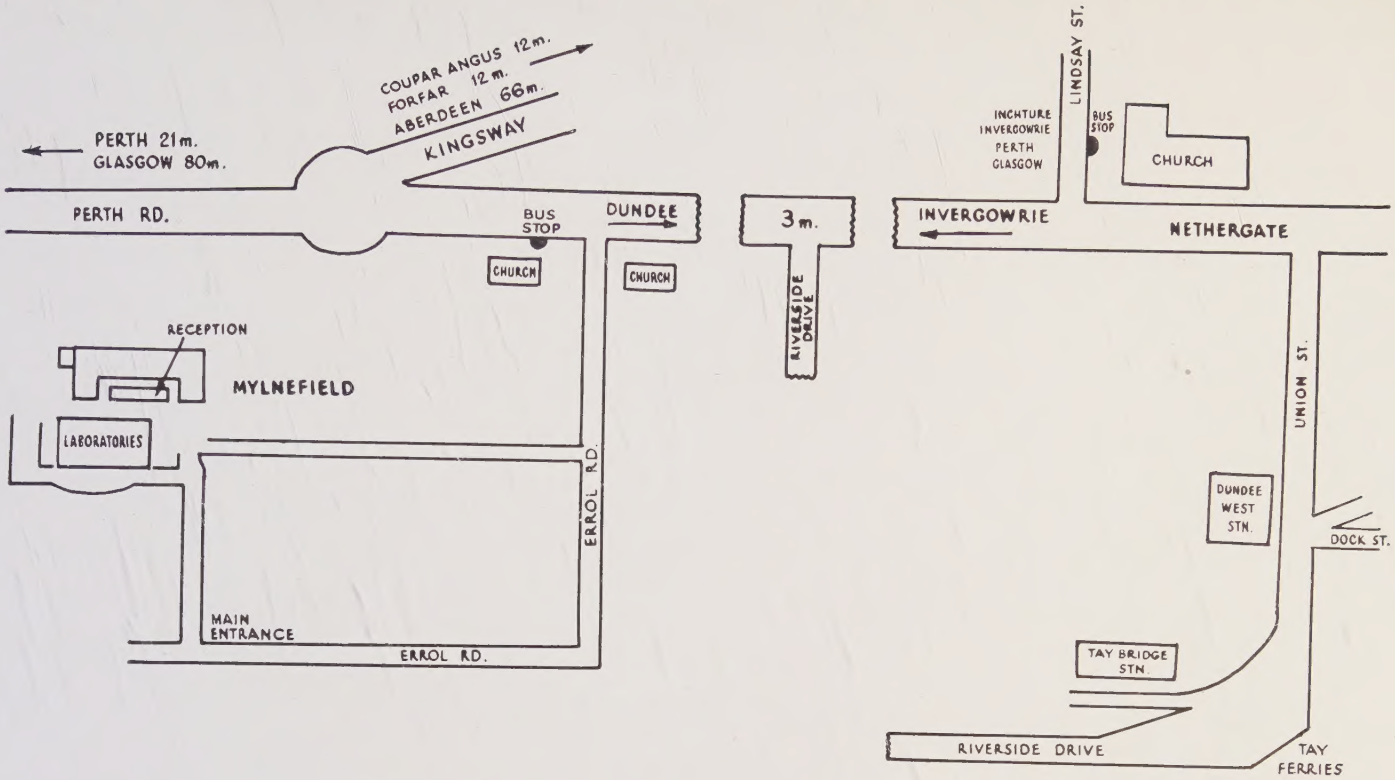

Sketch plan of routes to the Institute